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LENOX AND FOUNDATIONS

Foundry Trade Journal, AND THE IRON AND STEEL RECORD.

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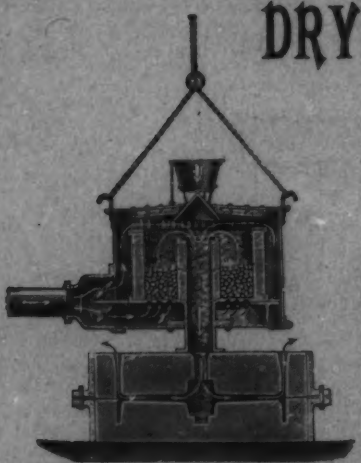

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THE FOUNDRY TRADE JOURNAL.

AND

The IRON and STEEL RECORD.

Vol. 5. JUNE 18, 1904. No. 30.

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BRITISH FOUNDRYMEN'S ASSOCIATION.

WE are pleased to learn from the Hon. Secretary that the Association is progressing satisfactorily. Although only inaugurated a couple of months, the membership already numbers more than fifty Foundrymen from England, Ireland, Scotland, and Wales.

At a committee meeting held at Birmingham, on Saturday, June 11th, it was decided to hold the first Annual Convention of British Foundrymen at Manchester, commencing on Tuesday, August 2nd, 1904, when papers will be read by eminent men in the Foundry Trade, and then discussed by the members. It was also decided to have the papers printed for the use of members. This convention will be the first of its kind held in England, and the executive of the British Foundrymen's Association appeal to the Foundrymen of Great Britain and Ireland to render them their wholehearted support to make the convention a complete success. "Onward and Upward" should be the watchword of every Foundryman of this country, and his surest success of attaining this ideal is in doing his utmost to assure the lasting success of the British Foundrymen's Association.

The Hon. Secretary is anxious to supply any further information, and will be glad to have communications addressed as under:

F. W. FINCH, *Hon. Secretary, British Foundrymen's Association,* Kingston House, Lansdown Road, Gloucester.

Correspondence.

FLUIDITY.

To the Editor of THE FOUNDRY TRADE JOURNAL.

DEAR SIR,—In the paragraph on "Fluidity," in "Notes on the Physics of Cast Iron," given in the May number of your Journal, it is said that "Oxidation has an important bearing on the fluidity of the metal, and a bath of highly oxidised metal loses its fluidity so rapidly, etc."

To say that a metal is oxidised is to say that it has chemically combined with oxygen, and, in the case of the metal being iron, to say that iron oxide has been formed; and to talk of it being *highly* oxidised is to say that a large proportion of the iron has so combined. A mere skin of iron oxide on the surface would not justify the term "highly oxidised," nor could it of itself much affect the molten metal underneath. Is it, then, possible for the molten metal in the bottom of a cupola to become so mixed with oxide of iron as to have its fluidity much reduced; and if so, how is this oxide formed? It can surely not be from the blast, because this only can play on the top of the molten metal, and possibly not then if there is slag on the top.

In the paragraph on "Fracture," in same notes, it is stated that "The fracture of an iron is directly related to its chemical composition." From what follows in the paragraph, it is the appearance of the fracture that is evidently referred to. If this is so, how can the statement be right, when, in the same paragraph, the writer explains how furnacemen alter the appearance of fracture of the same iron by slow cooling? Again, what is meant by the words *directly related* in the statement?

Perhaps some of your correspondents could shed some light on these matters to the interest of your readers, and yours truly, W. D.

PRESSURE ON MOULDS.

To the Editor of THE FOUNDRY TRADE JOURNAL.

DEAR SIR,—In replying to "Mr. Shaw" and that of "Mr. W. H. P.," allow me briefly to say that I do not intend to tread far on your valuable space, or patience, which I think may by this time be a diminishing quantity on the above subject.

I suppose it will be common to most people when they see a new "stalwart enter the arena of debate, to try and get to know such an one's weight and authority for doing so. But as "Mr. W. H. P." has kept this in the dark, we must try and get to the other side of his mask; and what we find there, the value will probably be in proportion to the impressions therein revealed.

Well, having put the foregoing process in operation, I think it will be admitted, in a general way, that "Mr. W. H. P." does not seem to have thrown much oil upon troubled waters, otherwise he would have entered into this debate in a more conciliatory spirit, and kept his somewhat acrid and ineffective criticism to himself, or at least have had sufficient manliness to have signed himself after the style of his friend "Mr. Shaw," or your humble servant the writer.

I find, in reviewing my previous Figs. that I am in error once or twice in calculating pressure; but as this has been allowed to go unchallenged, nothing more need be said about it. But, if it be not clearly enough given in the text concerning Figs. 7 and 8 to those who have followed this discussion from beginning to end, surely it must be clear enough in the context—that those Figs. represent the same bulk, and Fig. 8 is divided into three separate parts, for the purpose as previously stated.

And now for "Mr. Shaw's" letter, let me say in a word, that it is quite up to my anticipations in its academical tone and philosophical construction; and looks to be the product of one who has been studying the philosopher's stone, by calling

to his aid such great minds as Archimedes, Newton, Eular, and every other modern philosopher, etc. But strange to say the only one of the three great men referred to, whose name is prominently identified with hydrostatics—that is to say, if we accept the science of "fluxions" and the theory of the tides, both of which are as remote from "ferrostatics in the Foundry," as distance divides the north and south poles from each other, is the name of "Archimedes, an engineer of great antiquity, born about 287 B.C."

Truly such evidence is too far-fetched for those who have to live by something else than romancing and the wagging of a glib tongue.

And what I would have "Mr. Shaw" to remember in this discussion is, that it is not the philosophy of modern founding, but the facts of Foundry practice, and the easiest method possible for a moulder to calculate the weight necessary for holding down a cope, or top part, at time of casting; a want I trust this correspondence has to some supplied.

Again, referring to "Mr. Shaw's" "universal communication of pressure," it is evident that he and those who think with him in this matter, have not comprehended the difference between universal communication of pressure and the law governing the buoyancy of floating bodies, or matter in suspension.

It is true that a vessel containing liquid of any kind, or a mould that is without cores, and filled with fluid metal, that for every inch added thereto, or drop, which is nearer the truth, the same cannot be added without diffusing its force on the general pressure of any vessel containing liquid, and every nook and corner, sides, top, and bottom of every mould containing fluid metal.

So much, then, for the universality of pressure. But what of the "buoyancy or equilibrium of floating bodies," which alone have any similitude to cores in suspension, and held by the aid of chaplets, stanguys, or otherwise. If "Mr. S." could but understand intelligently the difference between the buoyancy of cores and the "downward" of a hydraulic ram or hammer, paragraph 6 of his letter, in all probability, would never have seen the light of day.

For the life of me I cannot see where the imile between "the down pressure of a hydraulic ram of the vertical type," or even that of a "hydraulic hammer," can be put alongside what he would have us believe takes place when metal passes over "the top side of the core at time of casting," which has so frequently been referred to.

Truly he has fixed me this time for an epithet, such as "nonsense or twaddle." But I do say, advisedly, that until "Mr. Shaw" can prove that his "hydraulic ram and hammer" have sufficient buoyancy for floating in water as a core does in liquid metal, then, and not till then, will there be any similitude between hydraulic rams, buoyancy of cores, and lifting pressure. And let it be remembered that buoyancy of cores is practically at all times a fixed quantity, but, lifting pressure varies in proportion to the ratio of distance between the lifting pressure line and the fluid surface contents of the pouring and riser basins.

I am glad to note that "Mr. Shaw" has "pitted" me against the eminent American Foundry writer, Mr. T. D. West. This gives me an opportunity of touching upon tne or two noticeable features of change ohat have come over "Mr. West" in the method of calculating pressure in the Foundry; inasmuch as he now accepts ·25 to be near enough, "and by dividing the volume in cubic inches by 4, call it the weight in lbs." Page 17, March, 1904, issue of the *Foundry*. This article I commend to the study and criticism of all (as I do that of my own), which, in the writer's opinion, is an improvement on "Mr. West's" "weighting down of copes," in his "American Foundry Practice," published in 1882, but lacks the simplicity of determining the pressure line or bottom

of lift, getting the surficial content, multiplying same by the vertical height, and dividing by 4, by 112, and by 20, thus putting the method of calculating lifting pressure in the Foundry in a nutshell. Further, I note in this particular paragraph, wherein "Mr. Shaw" quotes "Mr. West" thus: "after a core becomes totally submerged its lifting power cannot be increased." Needless to say I am agreed with "Mr. West," "Mr. Shaw," and all who think so. But I come to the parting of the ways, when I emphatically declare that neither can it be decreased — because total immersion of a core unaided by force, while being an impracticability, is also an absolute impossibility, and ought to be known to all that pretend to have given the subject of the "equilibrium of floating bodies" any consideration at all. This subject will be referred to in a subsequent paper, under the title of "Ferrostatics in the Foundry," if circumstances permit the writer doing so.

In conclusion, it has been said that doctors, lawyers, and ministers of religion have differed since the world began. Surely then there is no reason why people purporting to write on Foundry practice should not, if they cannot see eye to eye, agree to differ also. The latter, I sometimes think, being the better part, for this reason, that in an interchange of ideas, whether on practical or theoretical lines, or a combination of both, which in my opinion is best, nothing but good to all concerned must inevitably follow.

And with a journal such as THE FOUNDRY TRADE JOURNAL has proved itself to be since its inception, whose usefulness I trust to see extending among the foundries, between employers and employees alike, much that is abstruse in "Pressure in Moulds," and other phenomena in the output of a Foundry, will, with intelligent workmanship and ordinary care, disappear. Again thanking you, Mr. Editor, for your many favours, I beg to subscribe myself for the present, WM. ROXBURGH.

QUERIES.

This department of the JOURNAL *undertakes the answering of queries in the following branches:* Blast Furnace Practice, Basic (steel making) Processes, Cast-iron, Malleable Cast-iron, Steel, Brass, Bronze, &c., *by eminent authorities in each branch. When necessary, the aid of chemical analyses, mechanical testings, micrographic, or microscopic examinations will be invoked.*

The queries will appear repeatedly till answered. No charge is made to readers for answers, except where chemical, mechanical, or micrographic analyses are necessary, in which case the actual fee paid by us will be charged.

There are many other queries outside the scope above referred to which reach us at various times which we trust our readers will afford us assistance in answering.

Communications should be addressed to the "Editor, THE FOUNDRY TRADE JOURNAL, 104 Great Russell Street, London, W.C.," *and marked outside* "QUERIES," *and must be accompanied by the correct name and address of the querist, not for publication, but as a guarantee of good faith, which will be treated, with strict confidence.*

Blackings.—Will any of your numerous readers kindly give their experience with regard to Blackings.

We are having some trouble in our Foundry in this respect. Our castings do not come out at all clean; sometimes we have to chip the facing off, then the casting has the appearance of having been moulded in loam without any Blacking on. We shall be indebted to your valuable journal and to any practical foundryman who will kindly give us a hint in this direction.—I remain, yours truly,

LOAM-MOULDER.

Brass Liner. — Being an interested party in this job, and as failure to get a good casting occurred two or three times, I have thought, by bringing it before your readers, there might be information forthcoming for all concerned in this class of work.

Not being a brass moulder myself, I can only deal with the surface of things,

and hope for a bit of give and take from all who may feel inclined to do so, and from what has been already given by your practical readers, I think your journal has improved by throwing its pages open for the discussion of practical questions such as "bad castings" or anything that is of interest in either shop or Foundry connected with the trade.

The casting in question when polished was more or less speckled with small black holes, say, in size from a pin point to about three-sixteenths of an inch, and of irregular dimensions which became aggravated by grouping themselves in several places from top to bottom in zig-zag fashion—this, of course, condemned the casting.

Some blamed it on the mixture of metal, others blamed it on the coke, and, as might be expected, the core and cope had their share of attention also.

All agreed that it was dirt, but as to where it came from remains as yet a puzzle.

If any of your readers would give us their opinion so as to assist us in future I shall feel obliged, and thus enable us to produce our work as near as possible with a first cast in this the age of keen competition. Wishing the journal the success it so richly deserves, I enclose my card and remain, yours very truly,

30th March, 1904. SUBSCRIBER.

Cupola Charges.—I have read a great deal in your paper about successful working of cupolas. I have been trying for some time to get the best results of ratio of iron to fuel for light castings; at the present time we are melting 10 ton × 8 cwt. to 10 ton × 12 cwt. per day to 17 cwt. of coke, ratio about 12 × 1, I believe; of course, this includes bed as well, which is 6½ cwt. I should be glad to know of anyone who has had better results.

FOREMAN MOULDER.

NOTES ON PIG IRON.

BY J. A. PHILLIPS.

THOSE of us who are not chemists, or metallurgists, and cannot analyse pig iron scientifically, have to resort to other methods, and in the past such methods have been very satisfactory and reliable, and will always play an important part in iron founding, whatever the Chemist will do for us in the future. The methods I speak of are those of testing by experience which is gained by continually using pig iron, by the appearance of the fracture when the pig is newly broken, by the sound emitted when the pig is struck, by the amount of power required to break the pig; such methods are old, and sometimes brought into ridicule by men of more scientific education, who call them the "rule of thumb," but there have been some very excellent castings turned out by these rules.

Of course, the choice of pig iron must, to a very large extent, be governed by the class of castings required. No one would think of putting hematite pig into "fire bars," or fire bar scrap into "cylinders."

There are so many brands of pig iron on the market, each claiming distinct advantage over all others, such claims so rarely fulfilled, and the shortcomings of which (when wasters are in evidence) are attributed to the moulder's carelessness or inability.

One does not hear very much in these days of such irons as "Medleywood," "Blenavon," "Ridsdale," "Graybrook," all are exceedingly good irons, but very expensive. The general trend to-day is towards cheaper brands on account of the keen competition in the foundry trade.

Middlesbro', Derbyshire, Cumberland, and Scotch are cheaper, and each have their ready advocates and are generally good and reliable.

There are some brands of pig iron with fantastic names, about which no one knows very much, except the sellers,

who claim, among other advantages, that their pig will carry more scrap than any other brand of a like quality; it may be that all scrap would give better results than a mixture with these pigs, for the scrap may be far the better iron of the two.

The writer was persuaded to try some inferior pig iron, by the advice from the office on account of its cheapness, one blow with the slogging hammer broke a bar into five pieces. The fracture presented a light ashy colour, smooth and scaly, and when melted an enormous quantity of slag was produced, showing that it contained a very high percentage of cinder, the metal was very sluggish so that large runners had to be cut on all moulds, and the castings required an excessive amount of trimming to cut these large runners off. It was a most difficult matter to get small castings to run, and very seldom a clean face when the castings were machined; of the many and various brands of pig iron the writer has used, he gives preference to "No. 3 Ayresome" (Gjers Mills, Middlesbro'), for general work this iron is most excellent. The bars when struck give out a low dull note, the fracture presented a somewhat dark blue colour with a suggestion of red in it, rough and serrated, and fairly large grains which cannot readily be separated by rubbing the fingers across the fracture, which can be done in the case with common irons.

The writer has seen a half bar of Ayresome pig dropped on the breaker several times before it broke, which, according to experience, stamps that iron as being strong and tough.

This brand of pig will carry more scrap than any other the writer has used, scrap in the ordinary acceptation of the term, not specially selected as some people wish to use when trying certain irons. The reader will be surprised when he reads that 4 cwt. of No. 3 Ayresome pig iron and 8 cwt. of fire bar scrap has made very fair castings. Small castings which have to be machined all over give exceedingly good results when cast with all Ayresome, it has been proved that the extra expense in the foundry has been saved twice over in the fitting shop by such castings, another good feature of this brand of pig, is when melted it is thinly liquid, it is all life, every (practical) foundryman will understand why any brand of pig possessing this property, is most valuable to all founders, less wasters, all corners run up sharp and edges well defined, less blowholes, or sulphur bulbs and many other things which occur when the metal is not good and hot.

It is so difficult to select a suitable iron from any chemical analysis given by our friends the metallurgists, but if they would give us the name of the pig irons which would give satisfaction for certain classes of work, we should be benefited to a very appreciable extent.

All we poor uneducated foundry foremen can learn from the secret of chemistry thus expounded is that iron contains so much per cent. of carbon, phosphorus, sulphur, silica, manganese, etc.

Were they to tell us the name and brand of pig that contained the exact constituents, and the class of work most suitable for, we should value their advice very much, or will some of the "practical foundrymen" exchange ideas, by giving the best results they have obtained with pig iron.

It is reported that offers of American iron for shipment to the Continent have been indicated to merchants on this side at cheaper prices than those current for Middlesbrough iron.

A new electric cantilever crane, which lifts 150 tons from the dock wharf into vessels' hulls 40 ft. away, has been made and erected by the Naval Construction Works of Vickers, Sons, & Maxim, Barrow.

THE EARLY BESSEMER PROCESS.

THE Bessemer process of steel making is essentially a chemical one, for starting with molten cast iron an entirely distinct product is obtained at one operation. Primarily, the process consists of blowing a large volume of compressed air through a bath of molten pig

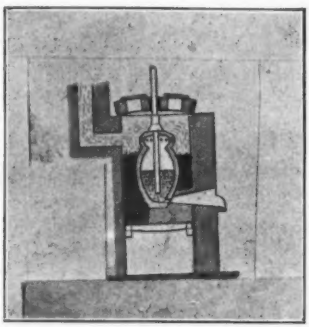


FIG. 1.

iron, the oxygen of the air combines with the carbon, silicon, and manganese, forming oxides which in the case of carbon are evolved as gases, whilst in the case of silicon and manganese slags are formed. Assuming the phosphorus and sulphur of the molten pig iron to be low, it will be seen that by the removal of the carbon, silicon, and manganese a product approaching wrought iron in composition may be obtained. This oxidation is accompanied by a considerable increase in temperature; were it not so the process would be of comparatively little value, and, as will readily be seen, the bath would solidify. However, the increase in temperature is such as to maintain even dead mild steel in the fluid condition, and permit of its being poured into ingot moulds. Bessemer originally described his process as a method of producing wrought iron without fuel, but as just shown the fuel necessary to the operation is self-contained—that is, it is derived from the combustion of the carbon, silicon, and manganese.

Bessemer's first patent was taken in October, 1855, and in August, 1856, he described the process in a paper read before the Cheltenham meeting of the British Association. This paper, entitled "The Manufacture of Malleable Iron and Steel without Fuel," attracted much attention from the iron masters of the country, and many experiments were tried resulting in not a few cases in total failure, the products obtained being brittle when cold and unforgeable when hot. Bessemer, with remarkable persistency, continued his experiments, tracing the source of the cold shortness to the presence of phosphorus and Swedish pig iron, low in phosphorus, was employed. Eventually the Cumberland hematites were found suitable for treatment in the converter.

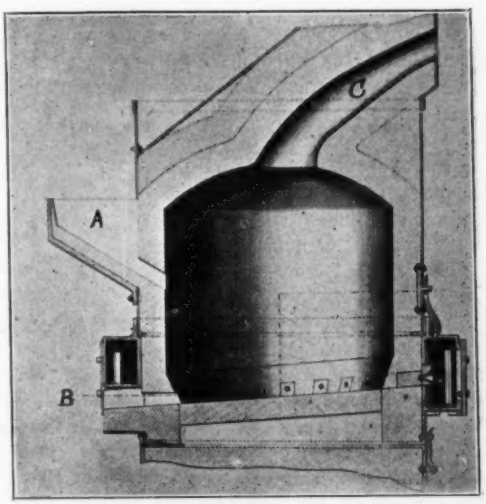


FIG. 2.

But whilst the source of cold shortness had been recognised and the remedy found in the use of low phosphoric irons the trouble due to unforgeability when

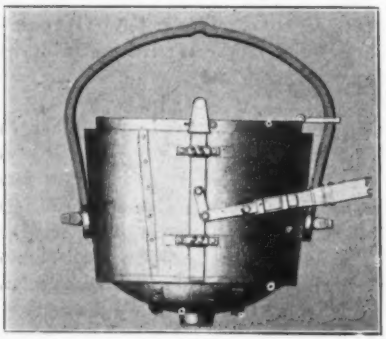


FIG. 3.

hot was not remedied, and much of the steel made was "red short," a fault due to the presence of oxygen. In other words, on the elimination of the carbon from the bath of molten metal, the excess of oxygen present combines with a portion of the iron, forming ferrous oxide. This oxide distributed through an ingot of steel renders it "dry" or crumbly when hot, and consequently unforgeable. Mushet's conception of the addition of manganese effectually eliminated red shortness; resulting in a steel capable of forging or rolling down to any desired shape or section. The manganese is added in the form of "spiegel" or ferro manganese at the termination of the "blow." When spiegel is used it is usually added in the molten condition. Thus, by the selection of a pig iron initially low in phosphorus, and by eliminating the oxygen from the decarburised metal by means of manganese, the two chief difficulties of the process were overcome. The resulting product represented a really good steel capable of production in any quantity and at a comparatively low cost.

Turning to the process, one of the first striking features is the state of perfection given to the method and the plant by its originator. This perfection was attained only after years of costly experiment, but so completely were the details worked out that to-day the acid Bessemer process varies very little from that introduced and put into actual work by Sir Henry Bessemer in his Sheffield works. One of the earliest experiments is shown in Fig. 1. In this case the charge of cast iron was melted in an ordinary crucible and steam blown into the molten metal by means of the pipe shown. Air was substituted for steam, and it was eventually found that external heat was unnecessary, thus leading to the adoption of a fixed converting vessel. These fixed vessels were gradually improved, resulting in a type shown in Fig. 2, which, according to Boman,* was used in Sweden. Round the bottom of this vessel a series of horizontal tuyeres, formed of fireclay tubes, are placed.

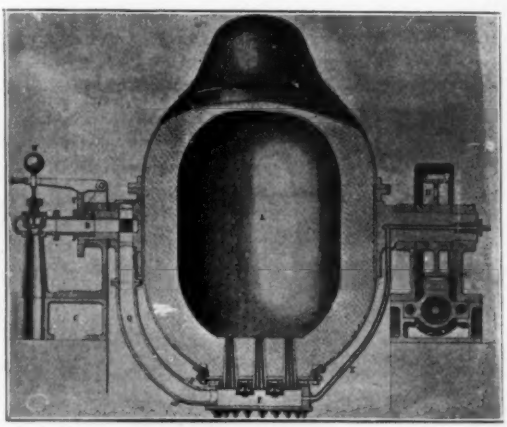


FIG. 4.

The shell of the vessel is formed of wrought iron plate, and the interior lined with refractory material. The molten pig iron is poured into the vessel by

* Kohn's "Iron and Steel Manufacture."

means of the spout A, and in order to prevent the tuyeres filling, the blast is turned on before the introduction of the metal. The products of combustion escape by the flue C, and on the termination of the "blow" the metal is tapped at B running into a ladle of the type shown in Fig. 3, this ladle being carried by a crane over the ingot moulds for casting. Further development from the fixed to the rotary converter will be best described in Bessemer's own words*: "Many forms of converting vessels were tried on the large scale before this desirable object was attained. In some of them the lining was too easily broken down by the violent motion of so heavy a fluid as iron; in some of the forms tried the angles allowed the metal to solidify in them and so clog the vessel, in others the mouth of the vessel being too small caused the metal to be thrown out by the force of the escaping blast. It was also found that if the mouth was too large the heat escaped, so as to cause part of the converted metal to solidify in the vessel; the relative height and diameter of the vessel was also found to produce important differences in the working of the process; finally, after many long and expensive trials, the present form of vessel was adopted (see Figs. 5 to 7). This vessel is made in two parts, so as to admit easily of its being lined with ganister, its form is that of an arch in every position, which prevents the lining from falling down by its own weight. There are no angles in which the splashes of metal can solidify and accumulate. Its mouth directs the flame and sparks away from the workmen, whilst the throat of the vessel and the position of the mouth almost entirely prevent the throwing out of the metal. The vessel is mounted on trunnions supported on pedestals so that a semi-rotary motion may be given. The tuyeres are placed at the bottom of the vessel, so as to force the air vertically upward through the metal without coming in contact with the sides. When the crude metal is to be run into the vessel it is turned on its axis nearly into a horizontal position, the mouth being a little higher up; a gutter will then conduct the crude cast iron from the melting furnace into the vessel. As soon as the air is admitted through the tuyeres the vessel is turned into the vertical position and decarbonisation immediately

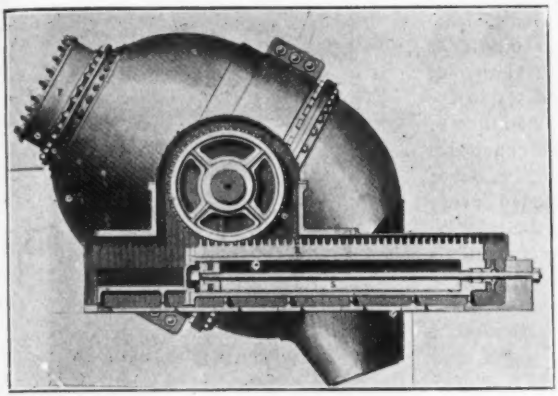


FIG. 5.

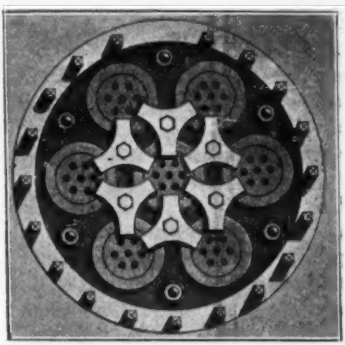


FIG. 6.

* Paper read before the British Association, September, 1865.

commences. As soon as this is effected as much molten pig iron, made from spathore iron ore, is added to the bath as will restore the quantity of carbon necessary to produce the desired quality of steel. The contents of the converter are then transferred to the casting ladle, from whence the steel is transferred to a series of iron moulds ranged in a semi-circular pit, each mould being placed within the sweep of the casting crane. The filling of these moulds is regulated by a cone valve made of fire clay and fitted in the bottom of the casting ladle, so as to be opened or shut by means of a handle outside the ladle."

To render the foregoing quotations clearer the accompanying figures are given. Thus Figures 4 and 5 show respectively a section and a side view of the converter. The rack, pinion, and hydraulic cylinder shown in the side view admit of the converter being turned on its bearings. As will be seen from Fig. 4, the left-hand trunnion supporting the vessel is hollow, and is connected by a blast main to the tuyere box, through which the blast is admitted to the tuyeres. Figures 6 and 7 show respectively the

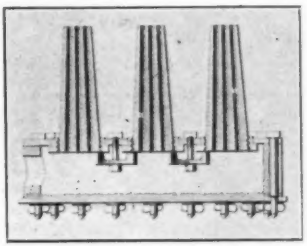


FIG. 7.

tuyere box and a section through the tuyeres. For much of the matter contained in this introduction to the early Bessemer process the author is indebted to Kohn's "Iron and Steel Manufacture," published in the year 1869. PERCY LONGMUIR.

BLAST FURNACE GASES: THEIR NATURE AND USE.

BY WALTER MACFARLANE, F.I.C.

IN the keen competition of these modern days, strict attention must be paid to details if the balance-sheet is to come out satisfactorily.

The gases which are given off from an iron-smelting blast-furnace have a value which is more and more highly appreciated. Time was—and not so long ago—when they were allowed to escape freely and go to waste.

Fifty years ago one might have seen in Staffordshire, long, vivid, tongues of flame leaping towards the sky, and illuminating with a lurid glare the whole district. Similar "pyrotechnic displays" could be seen in other iron-smelting districts. The economist had not then learned the full value of the gases, or how to employ them advantageously. At that time they were correctly called "waste gases." That term is now a misnomer.

Two questions arise: (*a*) "What is the nature of these blast-furnace gases?" and (*b*) "How can they be most profitably employed?"

As to the first question: The chief components of value are carbon monoxide; methane, or marsh gas; and hydrogen. These three gases can burn briskly, yielding much heat during their combustion—hence their usefulness. Let us consider each one separately.

Carbon monoxide is the most important constituent of producer gas—that gas which is manufactured so extensively in works where Slemens' steel is made, and which is now rapidly coming into use for many other porposes. It is made in gas-producers by burning coal slack* with an insufficient quantity of air. The explanation is, that when carbon (which is the chief constituent of coal) is burning, every *atom* of it likes to be joined to *two atoms* of oxygen (which is the vital constituent

* Slack is preferred because it is cheap, and its smallness is not a drawback.

of air) so as to form a gas which is known as carbon dioxide, or carbonic acid gas. If, however, there is a deficiency of air, or an excess of *glowing* carbon, then each carbon atom required to be contented, for the time at least, with *one oxygen* atom only, for using that very deadly, but useful gas, called carbon monoxide. Carbon monoxide, when afterwards brought into contact with air in a hot chamber, quickly unites with the additional oxygen needed to form carbon dioxide, and much heat is produced (or generated) when that second combustion takes place.

Hydrogen is a gas which bulks largely in the ordinary "coal gas," which is regularly supplied for illuminating purposes and for driving gas engines. When ignited it combines with oxygen, burns with a blue flame, and produces steam.

Marsh gas is a compound gas consisting of 3 parts by weight of carbon to 1 part by weight of hydrogen, although there are 4 atoms of hydrogen to 1 atom of carbon in it. When one in the course of a country stroll is tempted to idly stir the water and mud of a stagnant pool, gas may bubble freely to the surface. That is marsh gas, called methane in books on chemistry. It originates where certain plants grow under water. The deadly "fire-damp" which, escaping from cracks or fissures in coal-mines, may violently explode with disastrous results, is methane. It can be burned quietly, however. In the blast-furnace it is liberated during the decomposition of the fuel.

Now, it may be asked, "Why are these gases not fully consumed in the blast-furnace and the heat from their combustion take an advantage of within the furnace?" They are fully utilised in the Foundry cupola, why not in the blast-furnace? To answer that question we would do well to hark back and travel along another path.

What happens when a piece of wrought-iron is left exposed to atmospheric influences? It rusts. The combined attack of carbonic acid, moisture, and oxygen in the air causes the iron to lose its qualities of tenacity, toughness, weldability, &c., and to become a voluminous mass of crumbling brown matter altogether, unlike the bright, strong metal. The ores from which iron is extracted by smelting may be looked upon as being akin to iron rust, more or less altered and mixed with sand, clay, &c. To get iron from an ore, it is clear that we must separate out the sand, clay, &c., and we must also break up that chemical association of iron with oxygen. To effect the latter purpose, it is necessary to have in the working blast-furnace containing the ore, a large volume of reducing gas—that is, gas which is greedy for oxygen, such gases as those already named—carbon monoxide, hydrogen, and marsh gas. The tendency of these gases is to combine with oxygen. Carbon monoxide annexes, when it can, additional oxygen, from the iron oxide, and becomes thereby changed into carbon dioxide. Some of that carbon dioxide would part with its newly-acquired oxygen to the iron which has just been released from the oxygen—the newly deoxidised, or reduced, iron, and thus the blast-furnace work would be in some measure undone, and iron would be lost in the slag. To prevent the undoing and the loss, a large excess of these reducing gases must be present in the furnace.

The table on page 214 shows the composition of the gases from blast-furnaces, and, for the sake of comparison, the composition of good producer gas purposely made for steel smelting.

Only the reducing gases are of value; we cannot help the presence of the others.

It is noteworthy that the gases from the blast-furnace, after doing duty there, have a composition so near to that of gas expressly made by a modern method for providing the intense heat needed for steel smelting.

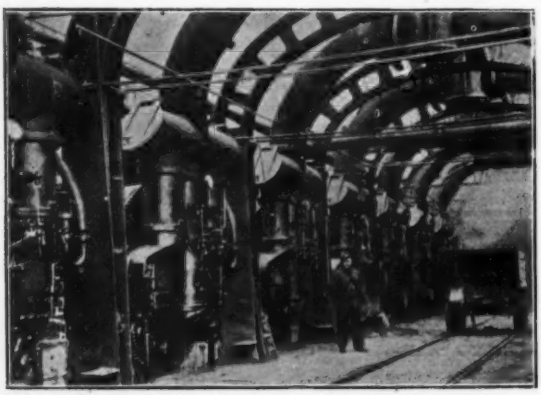
There is a constant current of gases passing upwards through the blast-furnace and steadily issuing from it. Because it is capable of being burnt—or to put it a little more learnedly, of being further

	Chemical Formula.	Gas from Blast Furnace using Coke.	Gas from Blast Furnace using Coal.	Producer Gas from Coal Slack.
Reducing gases:				
Carbon monoxide ...	C O	31·1	28·0	26·4
Hydrogen	H_2	1·3	5·5	11·7
Marsh gas	$C H_4$	0·2	4·5	1·8
Totals ...		32·6	38·0	39·9
Oxidising gas:				
Carbon dioxide ...	$C O_2$	8·5	8·8	4·3
Inert or neutral gas:				
Nitrogen	N_2	58·9	53·2	55·8
		100·0	100·0	100·0

oxidised, and thereby generating heat, or mechanical power, the "surplus gas" (a better name than "waste gas") is carefully collected and set to do useful work.

UTILISING THE GAS.—The ingoing air needed for the blast-furnace is preheated by burning as much of the gas as is needed for the purpose in hot-blast stoves*; the remainder is used for steam raising by being burned under long boilers—a regulated amount of air (about $7\frac{1}{2}$ vols. of air for every 10 vols. of the gas) being admitted along with the surplus gas.

The accompanying view of the gas-fired boilers at Messrs. Bell Brothers, Clarence Works, near Middlesbrough, may convey an idea of the arrangement.



GAS-FIRED BOILERS AT MESSRS. BELL BROTHERS.

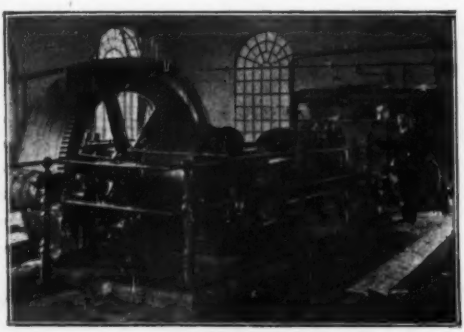
Overhead are the main pipes for conveying the surplus gases to the boilers.

A newer method is to use the surplus gas direct in gas-engines. For this purpose the gas must be thoroughly scrubbed, so as to free it from all but traces of fine dust. It is impossible to avoid the constant carrying over of dust in the current of gases, and as the volume from a working blast-furnace is almost inconceivably vast, the problem of getting rid of dust—presence of which would ruin a gas-engine—is a large and troublesome one. The dust may be conveniently considered as one of three grades—relatively coarse, intermediate, and fine. The coarse settles out without much trouble if enough "travel" is allowed—that is, if there is sufficient distance between the "downcomer," through which the blast-furnace gases are led off, and the gas-engine. Sometimes the finest of the dust is of a lubricating nature, and its presence is beneficial. The intermediate grade is the worst to deal with, and of methods adopted for its removal from the gas mention may be made of two. First: Allowing the gas-room to expand by interposing large towers, like big boilers

* See page 85, March Number of the F.T.J., for a description of a modern hot-blast stove.

set up on end, in its course. And as a pent-up stream may, in its swift current, easily carry sand and stones with it and deposit these where the stream widens out and the flow becomes sluggish, so the slowing down of the current in these settling towers favours the separation and deposition of dust particles from the gas.

The second method for hastening and completing the separation of dust consists in directing a fine spray of water towards the centre of the pans used for propelling the gas. In this way a mist or fog is created, and as fogs are apt to cause the suspension of fine particles, the gases are well cleaned in the fan-chamber where the fog predominates and the very fine dust is deposited on a bank of coke in another part.



BLAST-FURNACE GAS ENGINE AT SIR ALFRED HICKMAN'S WORKS.

For every ton of Foundry pig-iron produced in a Cleveland blast-furnace, six and a half tons of gases are produced.

The volume is enormous. A blast-furnace which is in good working order will give off per day a larger bulk of gas than one of our important City Corporations will supply for illuminating and power purposes in the same period. The gases require to be very effectively scrubbed if the gas-engine which it impels is to run smoothly and continuously.

Great as is the economy effected by collecting the gases, preheating the blast, and employing the remainder for steam raising, the power gained by using the surplus direct in gas-engines is greater, perhaps three or four times as much. This is a most notable advance, and the successful instalment of more large gas-engines in our principal works will be watched with interest. At Sir Alfred Hickman's works a magnificent set of powerful engines, worked by cleaned blast-furnace gas, has been erected. In the Sheepbridge Iron Works, Derbyshire, all the surplus gas is sent to a central gas-engine station, and power is there generated, by which all the conveying and charging of furnace materials is performed, and the mechanical work in connection with a Foundry making 400 tons of pipes and castings per week is done.

In another work the surplus gas distils the tar and ammonia liquor, heats the hot blast stoves, provides steam for the whole works, melts the steel in the steel Foundry, heats the core stoves for three large foundries, burns the ore briquettes in a 12-chamber kiln, distils the coal for the gasworks supplying the village, etc.

Whether or not we shall arrive at the period when, as predicted by an eminent authority, pig-iron will become a subsidiary product of the blast-furnace, time will tell. Certain it is that more and more attention is now being paid not only to the cheap production of good pig-iron, but to the utilising of blast-furnace gases and slags, with a view to making the most of both.

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THE INFLUENCE OF VARYING CASTING TEMPERATURE ON THE PROPERTIES OF STEEL AND IRON CASTINGS.

Read at the Iron and Steel Institute, May, 1904.

By Percy Longmuir (Sheffield), Carnegie Research Scholar.

THE occasionally erratic behaviour of castings of known composition and suitable treatment is familiar. Steel castings of identical composition and annealed under similar conditions show at times a wide variation in their mechanical properties. Further, with equal properties, as shown by the tensile test, steel castings may under certain conditions vary in their resistance to working stresses, and in extreme cases fracture may occur at comparatively low stresses. Another source of variation lies in the resistance offered by steel or iron castings to the percolation of water under pressure, and not infrequently this may be met with in similar castings poured from the same ladle.

The present state of Foundry practice is such that all conditions, save one, may by the exercise of suitable care be held in good control. That one condition is the temperature of the metal as it enters the mould, and to it the following work has been devoted.

Generally the methods outlined in a former paper have been followed, and every experiment represents identical conditions other than casting temperature. All conditions being strictly comparative, it follows that the results obtained, whether in the cast, annealed, or heat treated condition, represent actually the influence of varying casting temperature.

The work has been conducted in the Metallurgical Department of University College, Sheffield, and the many facilities possessed by the college have been freely placed at the author's disposal. Professor Arnold has shown a keen interest in the progress of the work, and the author is indebted to him for many valuable suggestions and much kindly counsel.

Cast and Malleable Cast Iron.

Preliminary experiments with various types of cast iron conclusively proved the susceptibility of this metal to the influence of casting temperature. Commencing with an extremely hot metal, the tenacity of the cold bars gradually rises as the temperature falls until the "fair" heat is reached, a further fall in casting temperature being accompanied by a corresponding decrease in tenacity. Composition in each series remains constant, the varying properties of metal from one crucible or one ladle is in all probability due to the influence of casting temperature on the intercrystalline cohesion. In the case of white iron this influence survives the annealing process as followed for the production of malleable cast iron.

In no experiment undertaken has the influence of varying casting temperature failed to show, and none of the forms of after treatment adopted have brought the metal to a uniform level. Owing to this agreement over a wide range of composition this section has been condensed. Results obtained from a typical white and grey cast iron are embodied in Table I.

It will be noted that numbers 34, 35, and 36, all poured from one crucible, yield tenacities of 10·7, 15·9, and 12·1 tons per square inch respectively. Companion bars, after undergoing a treatment involving decomposition of one of the chief constituents, and a complete rearrangement of the structure, still exhibit a variation forcibly shown in tenacities of 20·6, 29·2, and 26·5 tons per square inch.

The grey iron is also noteworthy. An examination of Nos. 37 to 39 show that a fall in temperature of 50deg. C. raises the maximum stress 4·4 tons, whilst a further fall of 105deg. C. lowers it 3·5 tons. The

TABLE I.—*Showing the Influence of Varying Casting Temperature on the Properties of Cast Iron.*

No.	Analysis.						Casting Temperature.	Condition.	Mechanical Properties.		
	CC.	Gr.	Si.	Mn.	S.	P.			Elastic Limit. Tons per sq. in.	Maximum Stress. Tons per sq. in.	Elongation per cent. on 2 in.
34	3·4	...	0·39	0·05	0·02	0·02	1320° C.	As cast	...	10·7	...
35	,,	...	,,	,,	,,	,,	1230° C.	,,	...	15·9	...
36	,,	...	,,	,,	,,	,,	1120° C.	,,	...	12·1	...
34HT	0·77	2·57†	,,	,,	,,	,,	1320° C.	Heated to 1000° C. and slowly cooled	...	18·6	...
35HT	,,	,,	,,	,,	,,	,,	1230° C.		...	24·0	...
36HT	,,	,,	,,	,,	,,	,,	1120° C.		...	21·6	...
34A	0·2 to 0·5*	3·2	,,	,,	,,	,,	1320° C.	Annealed 100 hours in ore	20·0	20·6	1·0
35A	,,	,,	,,	,,	,,	,,	1230° C.	,, ,, ,,	24·3	29·2	3·5
36A	,,	,,	,,	,,	,,	,,	1120° C.	,, ,, ,,	22·5	26·5	2·0
37	0·52	3·4	1·78	0·28	0·04	0·27	1400° C.	As cast	...	9·7	...
38	,,	,,	,,	,,	,,	,,	1350° C.	,,	...	14·1	...
39	,,	,,	,,	,,	,,	,,	1245° C.	,,	...	10·6	...
37HT	Not estimated		,,	,,	,,	,,	1400° C.	Heated to 940° C. and cooled in air	...	7·1	...
38HT	,,	,,	,,	,,	,,	,,	1350° C.		...	9·9	...
39HT	,,	,,	,,	,,	,,	,,	1245° C.		...	8·5	...
37A	Not estimated		,,	,,	,,	,,	1400° C.	Annealed for 48 hours in a Clinch Jones muffle	...	6·5	...
38A	,,	,,	,,	,,	,,	,,	1350° C.		...	7·2	...
39A	,,	,,	,,	,,	,,	,,	1245° C.		...	2·6‡	...
37Q	Not estimated		,,	,,	,,	,,	1400° C.	Heated to 940° C. and quenched in water	...	2·5	...
38Q	,,	,,	,,	,,	,,	,,	1350° C.		...	3·0	...
39Q	,,	,,	,,	,,	,,	,,	1245° C.		...	2·7	...
43	3·35	...	0·03	0·03	0·02	0·02	1440° C.	As cast	...	9·4	...
44	,,	...	,,	,,	,,	,,	1299° C.	,,	...	12·1	...
43HT	Not estimated		,,	,,	,,	,,	1440° C.	Heated to 1000° C. and cooled in air	...	13·3	...
44HT	,,	,,	,,	,,	,,	,,	1299° C.		...	17·2	...
43A	Not estimated		,,	,,	,,	,,	1440° C.	Heated to 1000° C. and cooled in muffle	...	18·8	...
44A	,,	,,	,,	,,	,,	,,	1299° C.		...	20·5	...

* Varies according to proximity of drillings to outside or centre of bars, from 0 to 0·2 and 0·5. † Results obtained from average drillings. ‡ Flaw.

quenching experiments in this case are negative results included only for their general interest. As anticipated, the bars were finely fissured, and apparently some portion of the free carbon had entered into combination with the iron. Nos. 43 and 44 represent a type of unsound composition poured at a "high" and "fair" casting heat, both sets of bars being equally unsound. In spite of this equal unsoundness the tenacities show a difference of 2·7 tons per square inch in favour of the fair heat, and a distance apart is still maintained on subsequent treatment.

These results, confirmed by the preliminary work, sufficiently show the importance of casting temperature in the case of cast iron. The chief object of this research is, however, to show its direct bearing on Foundry practice, and it was desired to ascertain if this influence holds good in all cases, irrespective of (1) composition, or (2) size of the castings. Work is now progressing in this direction; and the first series of results are embodied in Table II. These bars, 16in. long by 0·5in. diameter, were selected in order to determine if the relatively rapid solidification minimised the effect of varying casting temperature. The plan followed was to secure three sets of three bars each at three distinct temperatures from one crucible. One bar of each set was tested as cast, and the remaining two after treatment. The influence of casting temperature is well shown, but on the whole the results are low, owing to the small diameter and long length of the bar under test.

Steel Castings.

As in the cast iron section, only sound bars are here considered, and casting temperature is for the present studied solely in its relationship to the mechanical properties. At the outset, it is well to state that mild steels are not readily overheated in the crucible furnace, and no telling example of excessive casting temperature has been obtained from mild crucible steel. Good examples of "scalded" tool steel have been obtained and with mild castings the low temperatures have yielded important results.

Recognising the difficulty of producing typical high casting temperatures, Messrs. D. Rennie & Co., Camlachie Steel Foundry, Glasgow, kindly placed a 2-ton Robert Converter at the service of this research. Mr. D. Rennie, jun., and Mr. G. Rennie entered heartily into the matter, furnishing the author with unlimited material of known casting conditions. Special blows have been conducted, and several series of castings representing various casting temperatures obtained. All other conditions are equal, and each series of annealed bars received exactly the same treatment. Careful analytical examination has, as yet, detected no change in composition, in any one series, due to variation in casting temperature.

The author would here tender Messrs. Rennie his most cordial thanks for their interest in the matter, for their favour in supplying several series of bars, and, above all, for independently confirming many of the results.

The results embodied in Table III. show clearly the influence of varying casting temperature on steels that have been initially overheated. It will be noted that one of the series of this table is abnormally high in sulphur. This experiment was specially conducted to ascertain the influence of varying casting temperature on the properties of a mild steel comparatively low in manganese and fairly high in sulphur. An examination of Nos. 90, 91, 92, and 93 is not without interest, the influence of casting temperature is distinctly shown on the tenacities both in the cast and annealed condition. The bending angles of the annealed bars were 75deg., 120deg., 80deg., and 70deg. respectively, and from steels of low extensibility these bending angles are comparatively high.

The remaining steels of Table III. are normal as far as composition is concerned, and attention is drawn to the

TABLE II.—*Showing the Influence of Varying Casting Temperature on the Properties of small Iron Castings.**

Test Bars, 0·5 in. diameter × 16 in. long. Length of piece under test, 9 in.

No.	Analysis.						As Cast.	Heated for Three Periods of 7 hours at 1000° C.	Heated to 1000° and slowly cooled.
	CC.	Gr.	Si.	Mn.	S.	P.	Maximum Stress. Tons per sq. in.	Maximum Stress. Tons per sq. in.	Maximum Stress. Tons per sq. in.
A 50	3·4	...	0·04	0·03	0·03	0·02	6·5	5·0	4·9
51	,,	...	,,	,,	,,	,,	8·0	7·3	10·0
52	,,	...	,,	,,	,,	,,	6·2	6·9	7·5
B 53	3·4	0·06	0·11	0·10	0·02	0·02	5·3	8·6	7·3
54	,,	,,	,,	,,	,,	,,	9·1	13·5	13·0
55	,,	,,	,,	,,	,,	,,	8·4	10·0	8·9
C 56	3·3	0·21	0·35	0·18	0·04	0·013	4·0	7·5	8·4
57	,,	,,	,,	,,	,,	,,	8·9	10.6	14·0
58	,,	,,	,,	,,	,,	,,	6·4	8·3	9·0
D 59	3·0	0·35	0·45	0·17	0·04	0·017	5·0	Not tested. †	11·3
60	,,	,,	,,	,,	,,	,,	8·3	10·0	14·1
61	,,	,,	,,	,,	,,	,,	7·1	9·3	11·2
E 62	...	...	0·61	0 08	0 02	0·012	5·6	7·0	8·9
63	...	...	,,	,,	,,	,,	9·0	9·8	13·6
64	...	...	,,	,,	,,	,,	6·7	,,	11·0
F 65	...	...	0·80	0·09	0·02	0·014	6·5	7·9	9·4
66	...	...	,,	,,	,,	,,	8·0	10·0	14·5
67	...	...	,,	,,	,,	,,	6·1	9·2	10 3
G 68	...	...	1·12	0 08	0·03	0·015	7·6	Not tested. †	8·6
69	...	...	,,	,,	,,	,,	11·0	,,	13·2
70	...	...	,,	,,	,,	,,	6·7	,,	8·3
H 71	...	...	1·47	0·30	0·03	0·011	7·0	7·6	7·0
72	...	...	,,	,,	,,	,,	10·0	11·1	12·8
73	...	...	,,	,,	,,	,,	8·8	9·0	8·3
I 74	...	...	2·1	0·40	0·05	0·02	5·8	4·0	5·5
75	...	...	,,	,,	,,	,,	12·0	8·0	12·0
76	...	...	,,	,,	,,	,,	5 5	6·2	5·8
J 77	...	...	2 7	0·30	0·04	0·02	5·3	Not tested. †	7·4
78	...	...	,,	,,	,,	,,	10·4	,,	12·1
79	...	...	,,	,,	,,	,,	7·5	,,	9 0

* The small diameter of these castings, and the relatively rapid solidification, prevent them showing the effect of an increasing content of silicon. A similar series of bars 1 inch diameter is contemplated.

† Seven of these bars were too warped to test.

elongations and contraction of areas. As these results show, the influence of casting temperature is not removed by annealing. The fact that extensions starting from 9·5, rising to 24·0, and falling to 8·0 per cent. may be obtained from one cast with metal in precisely the same condition other than casting temperature is of high practical importance. Nos. 84 to 86 cast at selected temperatures from one cast, and annealed together confirm Nos. 80 to 83. With a harder steel poured at selected temperatures from the fair heat downwards, the extensibility falls from 22·5 to 6·5 per cent. The results obtained from Nos. 90 to 93 illustrate not only the survival of casting temperature, but also show a type of steel not amenable to subsequent treatment.

The difficulty of obtaining typical "high" casting temperatures from mild crucible steels has been referred to; practically there is no danger of such metal being poured at too high a temperature.* There is, however, a strong possibility of the steel being cast too cold. A peculiar feature of mild crucible steels poured at "fair" and "cold" heats lies in the fact that generally their tensile properties are very similar, if not identical; the actual properties of these steels are, however, anything but similar, and from one crucible two castings may be obtained, one of which may be dangerously brittle.

Table IV. embodies some of the tensile results obtained from crucible steels. From the first three steels a steady fall in tenacity with a long temperature is perceptible. Nos. 97 to 100 embrace two steels of nearly uniform composition in three conditions, viz., cast, annealed, and forged, each condition including two distinct casting temperatures. This series is intended as a comparison of casting temperature on castings and forgings. Nos. 99 to 100 represent two ingots poured at the "fair" and "cold" heats respectively; they were cogged down to 1in. round bars under identical conditions —in other words, reheated to the same temperature, and both finished at the same heat.

The tensile results obtained from these steels as cast and forged are worthy of attention, and it will be noted that here the influence of casting temperature is not shown.* No. 98A in bending reached an angle of 160 deg., and then broke "short." The two ends of 97A were brought together without sign of flaw, both 99 and 100 being similarly treated. Yet in breaking pieces of 98A by means of a hammer decisive brittleness was shown and approximately these pieces required only one half the energy necessary to fracture similar pieces of 97A. This type of brittleness appears to be induced by a low casting temperature, and provided the steel has not been overheated, is not, as a rule, evidenced in the results obtained from a tensile test.

Professor Arnold has shown the existence of two distinct types of brittleness:† (1) mechanical brittleness, and (2) vibratory brittleness. The first is apparent, whilst the second type is met with in steels of good tensile properties, but which under certain conditions are liable to fracture under alternation of stress at a stress far below their elastic limit. Mr. E. G. Izod‡ has recently, in a paper read before the British Association, confirmed Professor Arnold's results. Professor Le Chatelier,§ in speaking of accidental fractures, has stated their source to be in the intermittent brittleness of the metal, "a brittleness not made apparent in the tensile test, but which is felt under certain conditions, especially when the metal is in use."

Early in the present research the question of brittleness assumed importance, and it was specially desired to ascertain if the second type described by Professor Arnold was a function of casting tempera-

* This statement applies only to mild castings, and does not include tool steels.

* When melting, the "fair" heat was not exceeded in either case.

† *Minutes of Proceedings of the Institution of Civil Engineers*, vol. cliv., supplement.

‡ *Engineering*, vol. lxxvi., No. 1969, p. 431.

§ *The Iron and Steel Metallurgist*, vol. vii., No. 2.

TABLE III.—*The Influence of Varying Casting Temperatures on the Properties of Steel Castings of Indentical Composition, poured from one Heat.*

No.	Analysis.					Condition.	Mechanical Properties.				Remarks.
	CC.	Si.	Mn.	S.	P.		Elastic Limit. Tons per sq in.	Maximum stress. Tons per sq. in.	Elongation per cent. on 2 in.	Reduction of area per cent.	
80	0·29	0·07	0·16	0·07	0·06	As cast	13·5	20·3	5·0	7·7	Poured in rotation at intervals from "high" to "low" during one cast.
81	,,	,,	,,	,,	,,	,,	14·3	24·2	9·0	12·9	
82	,,	,,	,,	,,	,,	,,	13·6	26·0	10·0	10·0	
83	,,	,,	,,	,,	,,	,,	12·8	25·0	8·5	10·8	
80A	,,	,,	,,	,,	,,	Annealed	12·5	24·2	9·5	18·0	80 to 23 annealed.
81A	,,	,,	,,	,,	,,	,,	13·5	27·2	24·0	3·3	
82A	,,	,,	,,	,,	,,	,,	13·3	27·0	12·5	17·5	
83A	,,	,,	,,	,,	,,	,,	13·2	25·5	8·0	12·0	
84A	0·28	0·15	0·29	0·06	0·05	Annealed	16·2	30·9	15·5	16·4	Representing three typical casting temperatures from one cast.
85A	,,	,,	,,	,,	,,	,,	15·4	28·0	33·5	45·6	
86A	,,	,,	,,	,,	,,	,,	16·4	30·3	27·5	39·2	
87A	0·51	0·11	0·42	0·06	0·05	Annealed	18·0	35·4	22·5	27·3	Fair to low casting temperature from one cast.
88A	,,	,,	,,	,,	,,	,,	17·0	36·7	20·0	16·7	
89A	,,	,,	,,	,,	,,	,,	15·7	36·2	6·5	8·4	
90	0·20	0·04	0·38	0·15	0·06	As cast	11·7	14·2	3·5	7·0	Example of the influence of varying casting temperature on a mild steel fairly high in sulphur.
91	,,	,,	,,	,,	,,	,,	14·8	21·5	5·0	8·6	
92	,,	,,	,,	,,	,,	,,	13·8	21·4	6·0	9·1	
93	,,	,,	,,	,,	,,	,,	12·6	17·5	3·5	8·0	
90A	,,	,,	,,	,,	,,	Annealed	11·4	15·8	6·5	11·2	90 to 93 annealed.
91A	,,	,,	,,	,,	,,	,,	13·0	22·1	7·5	13·4	
92A	,,	,,	,,	,,	,,	,,	12·5	21·8	10·0	9·2	
93A	,,	,,	,,	,,	,,	,,	12·2	20·8	10·0	9·0	
30HT	,,	,,	,,	,,	,,	Heated to 1000° C. and slowly cooled.	13·5	15·5	5·0	8·0	90A, 91A, 92A, and 93A heated to 1000° C. and slowly cooled.
91HT	,,	,,	,,	,,	,,		14·2	15·7	8·0	9·0	
92HT	,,	,,	,,	,,	,,		14·9	22·9	11·0	12·0	
92HT	,,	,,	,,	,,	,,		14·1	20·7	10·0	11·0	

ture. The results shown on Table V. are worthy of note; steel No. 97 withstood sixty-eight reversals of stress, whilst No. 98 fractured on forty-eight reversals. Even after annealing 98A is not brought to the same level as 97 in the cast condition. The forged steels are, however, of greater moment, the fair heat, No. 99, requiring 546 reversals to effect fracture, whilst the cold one, No. 100, required only 172. At present any definite statement on these results is hardly possible; there is, however, a strong probability that the cause of many mysterious fractures of steel of high ductility, as shown by the tensile test, may be traced to the original ingot being cast at either too high or too low a temperature.

The severity of the foregoing test may be exemplified by the following results. A casting showing a tenacity of 28 tons per square inch and an elongation of 26 per cent. fractured after forty-one reversals. Pure iron as cast and annealed fractured on 72 and 198 reversals respectively. As an extreme illustration, a casting of 38 tons maximum stress and 4 per cent. elongation fractured on four reversals, a similar casting poured at a slightly lower temperature broke on eight reversals. After annealing, these results were raised to 26 and 102 reversals respectively.

The Influence of Casting Temperature on Specific Gravity.—Much work has been devoted to this section, and with iron or steel no correlation has at present been established between casting temperature and density. However, as shown in the first part of this research, the appearance of runner heads is often a good index as to whether the casting temperature has been suitable or not. Similarly, the top surface of a steel ingot may also serve as a guide; reference to Fig. 21, Plate IV., shows three mild ingots from one cast, representing three casting temperatures.

MICROSCOPICAL.

On the whole, the net results of this section are not comparable with the work expended on it. The chief effort was directed to ascertain if the varying mechanical properties of iron or steel poured from one ladle could be satisfactorily explained by the influence of casting temperature on structure. The "fair" casting heat, as a rule, favours a less distinct type of crystallisation than either the "high" or "low" heats. The "low" heats are characterised by a very distinct type of crystallisation, and with medium carbon steels the junctions between the pearlite and the ferrite are very sharp. The fact has also been proved that the "loose" structure of the "high," the "interlocked" structure of the "fair," and the "sharp" one of the "low" casting heats survive an equal heat treatment.

The bulk of the work, however, indicates that the influence of casting temperature is exerted on the crystal junctions, for with each metal or alloy examined a certain casting temperature (the fair one) favours a distinctly stronger type of internal cohesion.

Thus when sections of pure metal, cast at typical "fair" and "low" heats, are etched under strictly comparative conditions, the crystal junctions of the latter appear before the former, and on termination of the etching the junctions of the "cold" metal are more pronounced, *i.e.*, deeper and broader. These conclusions are based on results obtained from zinc, tin, copper, and iron. References to Figs. 1 and 2, Plate I., illustrate this feature, and the difference in the crystal junctions of nearly pure iron, cast at 1653deg. C. and 1613deg. C., is readily apparent. In this and the following cases all etching conditions are strictly comparative; that is, each set of sections etched simultaneously in one dish and for exactly the same time.

In connection with the figures on Plate I., Professor Arnold described similar features in 1901,* and the following

* *Journal of the Iron and Steel Institute*, 1903, No. I., p. 175.

TABLE IV.—*The Influence of Varying Casting Temperature on the Properties o Steel Castings.*

No.	Casting Temperature.	Analysis.					Condition.	Mechanical Properties.				Bending Angle.	Remarks.
		CC.	Si.	Mn.	S.	P.		Elastic Limit. Tons per sq. in.	Maximum Stress. Tons per sq. in.	Elongation per cent. on 2 in.	Reduction of area per cent.		
94	1500° C.	0·47	0·22	1·04	0·05	0·016	As cast	24·0	38·6	4·5	6·0	30° broken	Three 50-lb. crucibles charged together but drawn at different temperatnres.
95	1481° C.	0·50	0·20	0·96	0·05	0·017	,,	24·6	36·4	3·0	5·4	23° ,,	
96	1431° C.	0·47	0·20	1·00	0·05	0·016	,,	18·5	31·0	2·5	3·8	10° ,,	
94A	1500° C.	0·47	0·22	1·04	0·05	0·016	Annealed	18·0	37·1	13·0	15·2	80° broken	Nos. 94, 95, and 96 annealed.
95A	1481° C.	0·50	0·20	0·96	0·05	0·017	,,	18·4	36·4	7·5	9·2	60° ,,	
96A	1431° C.	0·47	0·20	1·00	0·05	0·016	,,	16·8	22·5	3·0	8·1	35° ,,	
97	1550° to 1600° C.	0·36	0··2	0·89	0·02	0·02	As cast	18·4	35·8	12·5	12·4	75° broken	From one crucible. 98 poured two min. later than 97.
98	1470° to 1500° C.	,,	,,	,,	,,	,,	,,	18·0	34·2	11·5	17·4	80° ,,	
97A	1550° to 1600° C.	,,	,,	,,	,,	,,	Annealed	14·2	27·0	17·5	17·4	180° unbroken	97 and 98 annealed.
98A	1470° to 1500° C.	,,	,,	,,	,,	,,	,,	16·0	28·2	18·5	18·0	160° broken	
99	1550° to 1600° C.	0·37	0·18	0·87	0·03	0·02	Forged	25·6	40·9	27·5	54·0	180° unbroken	From one crucible. 100 cast 2 min. later than 99.
100	1470° to 1500° C.	,,	,,	,,	,,	,,	,,	24·5	40·1	28·0	50·0	180° ,,	
101	1611° C.	0·29	0·14	0·92	0·06	0·02	As cast	18·5	30·9	7·5	13·1	...	From one crucible. 1½ min. interval.
102	1560° C.	,,	,,	,,	,,	,,	,,	18·5	30·1	7·0	12·1	...	
101A	1611° C.	,,	,,	,,	,,	,,	Annealed	16·0	29·1	19·5	18·4	180° unbroken	101 and 102 annealed.
102A	1560° C.	,,	,,	,,	,,	,,	,,	15·2	28·4	18·5	18·4	105° broken	
103	1653° C.	0·08	0·04	0·06	0·03	0·01	As cast	...	...	...	...	180° unbroken	From one crucible. 1 minute interval.
104	1613° C.	,,	,,	,,	,,	,,	,,	10·3	18·7	15·0	27·4	180° ,,	
103A	1653° C.	,,	,,	,,	,,	,,	Annealed	...	...	...	...	180° unbroken	103 to 104 annealed.
104A	1613° C.	,,	,,	,,	,,	,,	,,	7·2	18·5	35·0	52·2	180° ,,	

TABLE V.—*The Influence of Varying Casting Temperature on the Properties of Steel as Evidenced by Alteration of Stress.*

DATA.—270 reversals per minute, $\frac{5}{16}$-inch stroke, test-piece $\frac{3}{8}$ inch × $\frac{3}{8}$ inch.

No.	Casting Temperature.	Condition.	Reversals to Complete Fracture.	Max. Stress. Tons per Square Inch.	Elongation Per Cent. on 2 Inches.
97	1550° to 1600°	As cast	68	35·8	12·5
98	1470° to 1500°	,,	48	34·2	11·5
97A	1550° to 1600°	Annealed	122	27·0	17·5
98A	1470° to 1500°	,,	62	28·2	18·5
99	1550° to 1600°	Forged	546	40·9	27·5
100	1470° to 1500°	,,	172	40·1	28·0

quotation from his research is included owing to its direct bearing: "On deeply etching the two under exactly the same conditions, FeB presented very large ferrite crystals with close joints, whilst 473 showed small crystals with loose junctions—that is to say, the etching acid developed broader spaces between them."

The influence of casting temperature on the structure is well shown in the case of white cast iron in Figs. 3 to 5, Plate II. The noteworthy feature is that these structures, after a complete rearrangement due to the decomposition of the cementite, still show a difference, as illustrated in Figs. 6, 7, and 8, Plate III. The high mechanical properties of Fig. 7 are readily explained by its structure, or rather its lack of structure, for the constituents so merge one into the other as to give the characteristic interlocking or interwoven type, whilst Figs. 6 and 8 are distinctly sharp.

Under various forms of etching the grey cast irons presented comparatively little difference, and practically none that could be definitely stated as due to casting temperature. On heat-tinting, the high temperature casting showed a large and irregular cellular structure, the "fair" casting heat presented similar features though on a much smaller scale, none of the cells being continuous, whilst the "cold" casting had a distinctly sharp appearance. Figs. 9 and 10, Plate IV.,

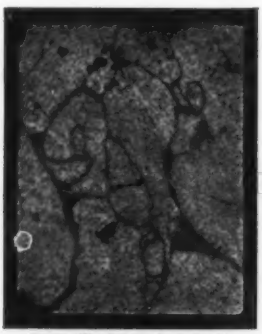


Fig. 1.—Nearly pure iron, as cast. Casting Temperature, 1658° C.

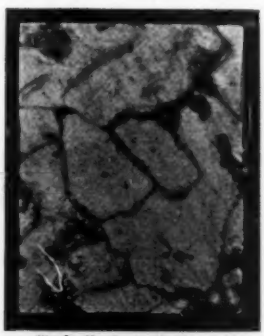


Fig. 2.—Nearly pure iron, as cast. Casting Temperature, 1613° C.

reproduce the "high" and "low" grey irons, and there the curious cellular structure referred to will be noted.

Fig. 3.—White cast iron. Casting Temperature, 1320° C. Maximum Stress, 19·7 tons.

Fig. 4.—White cast iron. Casting Temperature, 1210° C. Maximum Stress, 15·9 tons.

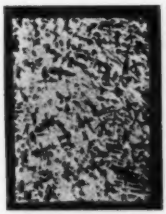


Fig. 5.—White cast iron. Casting temperature, 1130° C. Maximum Stress, 12·1 tons.

On Plate V. the structures of steels 84A to 86A are reproduced. The first of these steels was cast at a temperature probably

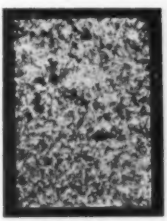


Fig. 6.—White cast iron. Annealed. Casting Temperature, 1320° C. Maximum Stress, 29·6 tons.

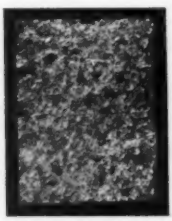


Fig. 7.—White cast iron. Annealed. Casting Temperature, 1230° C. Maximum Stress, 29·2 tons.

Fig. 8.—White cast iron. Annealed. Casting Temperature, 1120° C. Maximum Stress, 23·5 tons.

the highest possible for mild steel. The structure of the annealed steel (Fig. 11) is characterised by the distinctly sharp

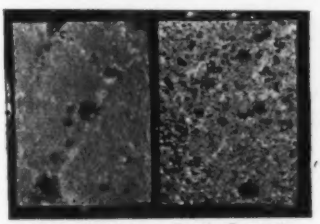


Fig. 9.—Grey cast iron. Heat tinted. Casting Temperature, 1400° C. Maximum Stress, 9·7 tons.

Fig. 10.—Grey cast iron. Heat tinted. Casting Temperature, 1245° C. Maximum Stress, 10·6 tons.

ferrite junctions, no similar junctions showing in Figs. 12 and 13. The merging of pearlite and ferrite one into the other without no apparent junction, typical of the "fair" casting heat, is well shown in Fig. 12, whilst in Fig. 13 these constituents are showing signs of a sharper separation.

Plate VI. reproduces the structures of three annealed castings of higher carbon content, commencing with the fair casting heat. The interlocked and broken structure of Fig. 14 gives place, with a falling casting temperature, to the sharper structures of Figs. 15 and 16. These steels, poured from one cast at different temperatures, and simultaneously annealed under absolutely identical conditions, form very telling examples of the survival of the influence of casting temperature through prolonged heat treatment.

Finally, Plate VII. represents four structures illustrating steels 90 to 93 in the cast condition. These steels were poured at intervals from "high" to "low." Fig. 17 is apparently the best structure of the four, and yet it represents

a tenacity of only 14·2 tons per square inch.

PRACTICAL CONSIDERATION.

This portion has been already treated in the first part of this research.* It may be well, however, to state again that a suitable casting temperature for any given alloy is not constant, but varies with the form and weight of the casting. Other determining conditions are the rate of pouring, the form of runner and gate, and the distance travelled by the metal before entering the mould. By taking advantage of these determining conditions, and commencing with a sufficiently high casting temperature, matters can be readily arranged so that each mould is poured at the correct heat. In determining this correct heat, experience must, until a very considerable advance has been made in pyrometer methods, be the only guide. Empirical though this may be, when carefully applied regularly successful results follow.

Fig. 11.—Steel, No. 84A. Elongation per cent., 15·5.

Fig. 12.—Steel, No. 85A. Elongation per cent., 33·5.

Fig. 13.—Steel, No. 86A. Elongation per cent., 27·5.

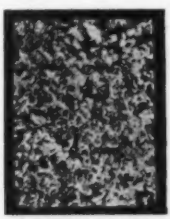


Fig 14.—Steel, No. 87A. Elongation per cent., 25·5.

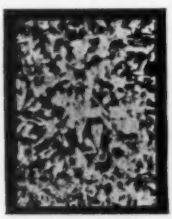


Fig. 15.—Steel, No. 88A. Elongation per cent., 30·0.

Fig. 16.—Steel, No. 89A. Elongation per cent., 6·5.

In conclusion, the author would again acknowledge the splendid facilities granted by, and ready advice always available from, Professor Arnold and his colleague, Mr. McWilliam.

The staff of the college have united in forwarding the research. It is impossible to acknowledge each individually, but to

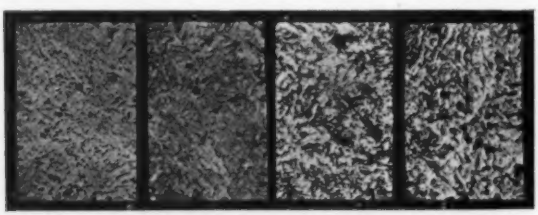


Fig. 17.—Steel, No. 90. Maximum Stress, 14·2 tons. Steel in the cast condition.

Fig. 18.—Steel, No. 91. Maximum Stress, 21·5 tons. Steel in the cast condition.

Fig. 19.—Steel, No 92. Maximum Stress, 21·4 tons. Steel in the cast condition.

Fig. 20.—Steel, No. 93. Maximum Stress, 17·5 tons. Steel in the cast condition.

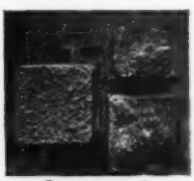


Fig. 21.—Three Siemens Steel Ingots.

A "Hot." B "Fair." C "Cold."

* *Journal of the Iron and Steel Institute*, 1903, No. I., p. 457.

Mr. F. K. Knowles the author's most cordial thanks are due. The students of the metallurgical department have rendered valuable assistance in the analytical portion of the work, and the author would specially acknowledge the services in this direction of Messrs. Clarke, Swinden, Moorhouse, Mather, Graham, Williams, and Brooke.

To Mr. D. Rennie, jun., and Mr. G. Rennie, of the Camlachie Steel Foundry, Glasgow, the author's highest thanks are due for providing material and independently confirming results.

The author would also acknowledge the accurate manner in which the many test-pieces have been machined by Mr. J. Harrison, test-piece maker to the college.

AMONG THE FOUNDRIES.

The Standard Ironworks, Barrhead, have been bought by the Barrhead Steel and Rivet Company.

The Rock Foundry, Machynlleth, Montgomeryshire, belonging to Mr. B. M. Davies, is being offered for sale by private treaty.

A. Stark & Son, Glasgow, have received the contract from the Glasgow Town Council for constructing the extension of the tramway system in Clydebank.

The Reading Town Council have accepted the tender of Messrs. Dick, Kerr & Co., Limited, for the supply of six bogie tramcars and an electric water cart.

Isaac Storey & Sons, Ltd., of the Empress Foundry, Manchester, have secured from the Preston Corporation for their tramways generating station the contract for condensing plant, cooling tower, and pipe work.

Bolckow, Vaughan & Co., Middlesbrough, have booked an order for 10,000 tons of steel rails from the London, Brighton and South Coast Railway Company, and also one for 4,000 tons for the New South Wales railways.

Hanna, Donald & Wilson, of Abbey Works, Paisley, have received the contract for a caisson for the dock which is being built at Hong Kong, and also the necessary hauling gear, which will be driven by a powerful electric motor.

The Dundee Harbour Trustees have accepted the tender of Messrs, A. & J. Main & Co., Ltd., Clydesdale Ironworks, Possilpark, Glasgow, for the supply and erection of steel-framed harbour buildings, which are to be 336ft. long by 120ft. wide.

R. W. Blackwell & Co.'s tender has been accepted for the execution of the whole of the work and the supply of the material for the new tram route from Dalton-square to the London and North-Western Railway (Castle) Station at Lancaster—a distance of about half-a-mile—and also doubling the existing line in South-road.

Thornycroft & Co., the well-known London shipbuilders, are negotiating for the purchase of the shipbuilding works now occupied by Messrs. Mordey, Carney & Co., at Woolston, Southampton. These works extend to an area of about 35 acres, but it has not yet been definitely decided, if they are acquired, whether the works at Chiswick will be removed to Southampton.

The Bloomfield Ironworks, Tipton, it is stated, are to be continued as a going concern, and additions to the plant are contemplated. Messrs. Bunch & Sons, of Walsall, who purchased the works last March, decided at the time to dismantle them in order to work the seam underneath, but the new proprietors now consider that, with certain alterations and improvements, they will be able to carry them on at a profit.

John Rogerson & Co., proprietors of Stannersclose Steel Works, Wolsingham, Durham, have placed with Messrs. Bruce Peebles & Co., Ltd., engineers, Edinburgh, a contract for the complete electrification of their works. The plant will consist

of three Lancashire boilers, two 150-kilowat high-speed engines with generators, 13 motors, 60 arc lamps, and the usual cables and small lighting.

The old-established businesses of Messrs. Scott & Co. and the Greenock Foundry Company, shipbuilders and engineers, Greenock, of which the late Mr. John Scott and Mr. R. Sinclair Scott were the sole partners, will in future be conducted under the name of Scotts' Shipbuilding and Engineering Company Limited, the interests and management remaining the same. None of the capital of the new company has been offered to the public.

The last of the Swan Garden Iron Works, Wolverhampton, is at hand. The plant and fixtures have been disposed of by Lysaght, Limited, to Mr. T. W. Ward, of Sheffield, who is shortly to commence the work of dismantling. There are 30 large boilers, 31 puddling and heating furnaces, 12 engines, 2 steam pumps, 5 cranes, 7 sets of shears, together with electric lighting plants at the works. It is understood that after the work of dismantling is accomplished nothing but the Foundry will remain, which is to be worked until the completion of a new one at Newport, whither Messrs. Lysaght have removed.

NOTES.

A layer of carborundum paste 2mm. thick will, it is claimed, protect furnace bricks against the varying high temperatures.

The value of metals and metal manufactures, including iron, lead, machinery, and hardware, imported into Cape Colony during January, 1904, was £261,000, compared with £400,000 in January, 1903.

E. H. Turner & Co., of 4, Lloyd's-avenue, Fenchurch-street, E.C., announce that they have been appointed sole London representatives of Stevenson's Metal Company (1903), Limited, Birmingham.

The secretary to the Chartered Institute of Patent Agents announces that a cablegram has reached the institute, from which it appears that the Australian Commonwealth Patents Act has now been proclaimed and is now in force, thus enabling protection to be obtained in the six States by a single patent.

Employment in ironstone-mining continues good. At the 133 mines and open works covered by the returns the average time worked was 5·67 days per week; in the month previous, 5·61 days; the same month a year ago, 5·64 days; but the number employed was 2·5 per cent. less than a year ago.

An interesting revival of the old Welsh ironstone industry is taking place at Blaenavon under Mr. G. Foster Martin, late of the Dowlais Iron Works, Cardiff. No. 9 blast furnace is being prepared for an output of 1,000 tons weekly. It was at these works that, three years ago, cold blast native ironstone was worked, the material being obtained from Aberdare.

Under the Factory and Workshop Act, 1901, the Home Secretary has issued a draft order which extends to male young persons employed in iron and steel Foundries, the special exceptions permitting young persons employed in a factory or a workshop to have the times allowed for meals at different hours of the day, and permitting young persons during the times allowed for meals in the factory or workshop to be allowed to remain in a room in which a manufacturing process or handicraft is being carried on.

A start has been made with the development of the ironstone mines on the estate of the Marquis of Exeter, near Stamford, Lincolnshire. A section of good quality has been proved, and the work of getting the stone is in progress. Samples have been taken by a number of pig-iron makers, and the quality so far tested is satisfactory. The mineral area is being further proved, and the indications are that it will be found to be of an extensive character. The ironstone

resembles in many respects that of Northamptonshire stone.

In the manufacture of iron and steel there has been a slight improvement in employment compared with the month previous and with a year ago. At the 195 works covered by the returns there were 74,488 workpeople employed; the total volume of employment, including the number of shifts worked and the total number employed, showed an increase of 0·8 per cent. above the previous month, and of 2·7 per cent. more than a year ago.

The Customs return of the iron and steel exports from Middlesbrough for May shows that 84,524 tons of pig-iron, 13,095 tons of manufactured iron, and 28,383 tons of steel were shipped—a decrease of 12,000 tons on April. The falling off was mainly due to Scotland. There was also a decline of 3,000 tons in manufactured iron and steel exports. The best customers for railway material and bridge work were India, South Africa, Egypt, Singapore, Russia, and Japan.

Some details are now available regarding the contract for the completion of the railway across the Andes, which separate Argentina and Chili, regarding which cable announcement was made the other day. The contract was let to a combination of three firms:—Messrs. S. Pearson & Son, London; Clark Brothers, London; and William R. Grace and Co., Valparaiso. It now transpires that the price to be paid for the completion of the work is £1,350,000, and as the Chilian Government had decided to guarantee 5 per cent. on a sum of £1,500,000, there is much satisfaction at the lowness of the figure, as it provides a fair margin under the Government guarantee for contingencies. It was such unforseen difficulties that prevented the former attempt to complete the work from being successful. Not only is the line at a very high altitude, but in the twenty-five miles of railway involved a height of 8,700 ft. must be overcome, so that the gradients will be very heavy. It is the part of the trans-continental line at the summit of the mountains which is involved, and there will be a spiral tunnel eight miles long on a continuous rising grade.

Scottish reports imply that the recent improvement in trade is only temporary, those who had anticipated the revival in the shipbuilding trade to be the forerunner of returning activity are realising that the art of prophecy is very difficult, and that one can easily be out of reckoning.

No doubt the worst of the trade dull spell has been seen, but it is apparent that any return to active times is going to be slow and uncertain. Steelmakers are well supplied with work at present, but find it most difficult to replace orders as they are executed, new work that does come along being only of a hand-to-hand character.

Consumers taking note of the stock of affairs will not treat for forward delivery, and expect to be able to deal at lower prices. Welsh and English competition with Scottish steelmakers is being felt, and already some of the latter have claimed to have prices reduced, but the bigger firms in the Scotch Combine oppose any reduction, arguing that it would be taken as a sign of weakness by customers.

There is a rumour of trouble in the Scotch Tube Combine, one of the firms having withdrawn, alleging that they were not fairly treated in the matter of orders. There is likely to be a rapid break in prices if the rupture is not quickly healed.

Malleable ironmakers are fast running through the orders in hand with very poor prospects of replacing them. Pipe-founders continue to complain of lack of work, one Glasgow Founder, however, has succeeded in booking an order for 5,000 tons of pipes for Japan.

O'Brien Thomas, Ltd., and **The Falkirk Iron Co., Ltd.**, have, we learn, concluded agreements whereby they will supply Cserny's patent fuel-saver attached to their stores.

MIDLAND NOTES.

FROM OUR OWN CORRESPONDENT.

THE trade in the Midlands shows a tendency to improve, and better orders are being booked. According to the Midland Iron Wages Board which met in the first week of this month, the return of the accountants on the output and average selling price of finished iron for April and May months, the output was slightly better than the previous return. It showed the tonnage for bars was 19,177; angles and tees, 791; plates and sheets, 1,899; hoops and miscellaneous, 5,232 tons; total, 27,090 tons, as compared with 26,424 tons in the preceding two months, but the average selling price was £6 8*s.* 5*d.*, compared with £6 10*s.* 2*d.* It was resolved that 8*s.* 6*d.* per ton be paid for puddling, and the wellmen's wages in proportion. The blast furnacemen's wages will remain unaltered.

A very fine piece of moulder's art is to be seen in the Tipton Victoria Park. Messrs. McFarlane, of Glasgow, have erected an elegant bandstand, at a cost of £325.

During the month the will of the late Mr. Edwin Jones, J.P., of Wyvelsfield, Chislehurst, and of the firm of Messrs. Bayliss, Jones & Bayliss, Ltd., Wolverhampton, fencing manufacturers, has been proved. He left estate valued at £227,707 gross, with personalty sworn at £215,156.

The city of Birmingham seems to be keeping its watchword "Forward" to the front in all matters. Recently a very valuable series of demonstrations have been held in the Lecture Theatre of the Metallurgy department of the Municipal Technical School. Mr. A. H. Hiorns—which, by the way, seems a very suitable name—has been lecturing to crowded audiences on the theoretical principles of the hardening of steel. He dealt with the subject in a very masterly manner, and showed the different methods and explained the different furnaces used for such purposes, and various quenching liquids. The cause of defects in hardening tools, and hints as to correct manipulation, were clearly explained. Practical demonstration as to the methods of quenching in a bosh of water, and also by means of water sprays, were given.

During the month an important conference has been held, when a meeting of ironmasters and blast furnacemen took place at the Queen's Hotel, Birmingham, with reference to the three-shift system. Sir Benjamin Hingley was in the chair, and in addition to the men's delegates there were present Mr. G. Tomkinson (district agent), and Alderman Wall, of Workington (general secretary). A very lengthy discussion took place, but no definite solution of the question was come to, and the conference was adjourned until next week.

The advisability of forming an engineering society in connection with the Wolverhampton Science and Technical School has been discussed; and the prospect of establishing such a combination has been received with much pleasure. It is proposed to call it the Wolverhampton and District Society of Engineers; but those engaged in the allied trades—such as moulders and casters—will be eligible for membership. The venture, it is anticipated, will prove a great success. It is also generally anticipated that the men will ultimately gain some concessions as regards the period of their present working shifts.

The Swan Garden Ironworks, Wolverhampton, are to be dismantled, the plant and fixtures having been sold by Messrs. John Lysaght, Ltd., to Mr. Thomas W. Ward, Albion Works, Sheffield. Only the foundry attached to these works will in a few days' time be standing, but this eventually will be demolished, when the new foundry at Messrs. Lysaght's works at Newport, Mon., is completed.

At a meeting of creditors of Ada Pitt, trading as Pitt & Co., who is the wife of Ralli Pitt, of Hall End, Wednesbury,

and carrying on the business of machine-tool maker and ironfounder, it was stated that the gross liabilities had been put down at £1,510 10*s.* 3*d.*, of which £1,091 was expected to rank for dividend for twenty-nine unsecured creditors. The debtor submitted the assets as being of the value of £499 19*s.* 11*d.*, leaving a deficiency of £591 8*s.* 3*d.*, and stated that the cause of her insolvency was "want of capital." Mr. H. A. Southerns, C.A., Wolverhampton, was chosen as trustee, and the following gentlemen were appointed as a committee of inspection: Messrs. G. H. Kitson, C. H. G. Davies (Trow & Co., Ltd.), and W. H. Richards (Richards & Co.). At the public examination of the debtor, who was represented by Mr. T. Jones, it was admitted that in 1897, when trading as a grocer, she was in financial difficulties, and Mr. George H. Kitson was then the chief creditor, his bill being £316. The stock and effects were sold up and she afterwards commenced in her present business, which she knew nothing of, but her husband managed it. She obtained from a Mrs. Wilson £500, in consideration of which she was to pay Mrs. Wilson half of the net profits. She did not know the cause of her present bankruptcy, as she left matters entirely to her husband. The examination stood adjourned until next week.

From coal selling to ironfounding one has to successfully cross a wide gulf, but according to statements made by a bankrupt in the Dudley County Court, it is very easy to start in the ironfoundry trade. The debtor was one James Stanton, residing in Martin Road, Park Lane East, Tipton. The liabilities were only £168 3*s.* 11*d.*, but the assets were nil. During an interesting examination, the debtor, who then described himself as a scrap-iron and marine store dealer, said he was brought up in the coal-selling business. His father gave him a horse and cart and he prospered in this line of business. About six years ago he sold it and started an ironfoundry, but at the end of twelve months he disposed of this business for £20 and took another foundry and carried that on for two years, and at the end of that time sold it for £35, after which he went into dealing with scrap, and money lenders.

The exhaustive inquiry attendant on the deaths of the four persons at the recent fire of Messrs. Thomas Holcroft & Sons, Limited., Ettingshall, has been the means of bringing to light several important facts as to the supervision of buildings intended for the storage of petroleum and other inflammable liquids. During the course of the inquiry, the inquirer pointed out that the local authority within whose jurisdiction the said works are situated should have made an inspection of any works in their district, and if that had been done the inspector could not have failed to notice the amount of oil that was stored there. The duties relative to such an inspection were made clear under section 14 of the Factory Act. It appeared in this case no licence had been granted for such storage, and in reply to this the clerk of the Bilston Council, within whose area Holcroft's iron Foundry is, said that his "council did not supply licences to those who don't apply for them." This statement came somewhat as a surprise, and expressions of opinion were freely exchanged, as it was clearly pointed out that it must be the duty of some person to report where there is no licence. The owners of unlicensed stores where licences were required are liable to a penalty, and it was incumbent on the part of someone to see that the law was properly obeyed, the council in question, through their clerk, submitted the matter did not fall upon them. The facts coming under public notice has had a very salutary effect in the Midland district, and the various public authorities are now bestirring themselves in the direction of seeing that all Foundries are properly inspected. It may be added that Messrs Holcroft & Sons, Limited., have carried out all the suggestions made by the

jury and coroner, and have erected new stores in such a manner that the risk of another similar disaster is reduced to the very lowest possible minimum.

Just as we were going to press with this issue we were favoured with an advance copy of the chairman's address and secretary's report delivered at the annual conference of the National Federation of Blastfurnacemen, Ore Miners, and Kindred Trades, which was held in the Co-operative Hall, Wolverhampton.

The chairman, Mr. J. Loughram, of Middlesborough, in his address, referred to the severe depression the nation had passed through since last they met. They were accustomed to witnessing fluctuations in the iron trade, yet the depression at the back end of last year and the commencement of this was exceptionally severe. He attributed this to the terrible drain upon the nation's wealth to meet the vast expenditure of the late war, for they knew that it would be ridiculous to expect that close on £300,000,000 could be drawn from productive employment and turned into unproductive channels without upsetting the trade and commerce of the nation.

The only important item at present calling for attention was the demand for an eight hours' day in the southern portion of that district, and as peaceful negotiations were at present pending they had reason to suppose that the change would be made here as in all other districts, by mutual agreement and without any friction.

He went on to say that perhaps the most important item on the agenda was that dealing with the appointment of an agent to organise and take charge of the eastern portion of the Midlands. For many years on the North-east Coast and on the West Coast and in the Western Midlands their men had been well organised and well disciplined, but they could not possibly remain idle while there were thousands of their brethren still unorganised and so utterly unfit to protect their own interests as to leave them practically at the mercy of unscrupulous employers. They found blastfurnacemen still working twelve hour shifts, and under such degrading conditions as to enable their employers to undersell other employers in the markets. They knew it could have but one effect, and that effect must be detrimental, since wages must rise and fall with the selling price of pig-iron.

He mentioned as another serious problem the large number of their members who were being displaced continually by labour-saving machinery. While they as a federation welcome all kinds of machinery that would relieve their members of slavish drudgery, yet they could not overlook the fact that whilst it is the profit on men's labour that enables masters to purchase machinery to displace them, the great majority of the men displaced, especially the older ones, have nothing but the workhouse or charity staring them in the face. That fact compels them to turn their attention to the ever-increasing necessity for old-age pensions.

The Secretary (Alderman P. Walls, of Workington), after speaking of the state of trade in the various ironfoundry districts, went on to state that since the holding of the last conference the Midland district had been strengthened by a friendly amalgamation with Oakengates, and the addition of new branches in South Staffordshire, a locality in which the weary twelve hours shift still drags on its weary and miserable existence. Whether it should continue to do so was, to some extent, a matter for them to decide. As far back as June, 1900, they advised strong measures. Those who had to try to carry out those measures perhaps tried too much to be conciliatory. He was learned in the Cleveland school, and always preferred that matters should be reasoned out, if anything like the same spirit was exhibited on the opposite side. Although they could not complain of the tone of the South Staffordshire ironmasters, they had just cause to complain

of their procrastination. They should speak plainly, and let the men know what course they mean to take. They spoke of old-fashioned plant, or obsolete management, or even of obsolete treatment of workmen. They hoped to settle that question amicably in the near future. If they could not, the course to be taken was in their hands. In North Staffordshire and Oakengates the sliding-scale agreement remained in force, and any change of conditions that might arise would be dealt with in an amicable spirit.

The conference was of three days' duration, and was attended by six delegates from the Cleveland district, five from Cumberland and Lancashire districts, and three from the Midland district, besides five delegates on behalf of the ore miners.

SHEFFIELD NOTES.

WITH the opening of the present month the general trade of the district remains practically unchanged, and a period of exceptional quietness is being experienced. The improvement mentioned in our last report has not been maintained, and the outlook at present is anything but of an encouraging character, especially to the workpeople, as the latter part of June or the commencement of July is given up to stocktaking with most of the firms in the district, and many who have usually set down for two or three days do not intend resuming work for some considerable time longer, unless work of an urgent nature is required.

High speed tool steel continues in good demand, but the competition for this class of work is getting keener and keener, the result of which is a cutting in prices. What was a short time ago in the hands of a few manufacturers is now made by almost every firm with a reputation in the tool trade.

The foundry trade both iron and steel call for no special comment; both departments are experiencing the same period of slackness that other branches are undergoing. At many foundries very little work above half the full capacity of each is being turned out.

The demand for railway material shows no signs of improvement, the only sections in this work being anything like busy are those engaged in the production of special steel rails, etc., for light railways and tramways.

The state of the heavy branches of the district is deplorable, very little Government work being in hand, nor can the outlook be said to be encouraging. The impression prevails that very little work in the way of armour, projectiles, and guns is to be expected for some considerable time.

On May 31st the Brightside Foundry and Engineering Co. completed an order for Messrs. Charles Cammell & Co. of a 42-ton armour plate ingot mould.

ALLOYS USED IN FOUNDRY PRACTICE.

PASSING from the copper alloys to those which for convenience were classed into Group VI. the first in order are the cast irons. An exact definition of cast iron is not easy to give, but it may be here taken as an alloy of iron and carbon, containing more than 3 per cent. of the latter element, and associated with greater or less amounts of silicon, manganese, sulphur, and phosphorus. The properties of any variety of cast iron are chiefly a function of its chemical composition, hence it will be well to study briefly the influence of composition.*

The elements present in cast iron are indicated in the foregoing paragraph; these five elements are present in every variety of commercial pig iron; in addition there may also be present arsenic, titanium

* See January, February, and March, 1903, issues of this journal.

and copper, but these three, if present at all, are usually in too small a quantity to affect the iron from a Foundry point of view.

Turning, then, to the five essential elements, the first and most important is that of carbon. This element may occur in two forms, and the particular form determines very largely the properties of the iron. Glancing for a moment at the following analyses:

Type of Cast Iron.	1. Soft Grey.	2. Mottled.	3. White.
Combined carbon...	0·20	1·60	3·40
Free carbon	3·30	1·90	0·10
Total carbon.....	3·50	3·50	3·50
Silicon	2·50	0·90	0·30
Sulphur	0·08	0·08	0·15
Phosphorous	0·15	0·15	0·15
Manganese.....	0·20	0·20	0·20

It will be seen that the chief difference lies in the silicon and the form of the carbon, in each case the total amount of carbon is the same, its condition only varying. Castings of No. 1 type may be drilled, filed, or machined with ease, those of No. 2 only with difficulty, whilst castings of No. 3 cannot be touched with ordinary tools. As far as cast irons are concerned, the condition rather than the amount of carbon present is the important feature, and the influence of the carbon condition is shown in the readiness with which the material may be machined. Thus the greater the amount of combined carbon the harder the metal, and *vice versâ* the greater the amount of graphite the softer the metal. Total carbon in cast iron seldom exceeds 4 per cent., if the combined carbon is high then the graphite will be low, and similarly high graphite means low combined carbon.

Graphite or free carbon has no direct softening effect, it acts as a softener indirectly by reducing the amount of combined carbon. Combined carbon is intensely hard, and is a definite chemical compound of iron and carbon, hence the term "combined carbon." On the other hand graphite is present in its elementary form; it is not chemically combined with the iron, but mechanically mixed with it, and may therefore be separated by mechanical means.

Silicon also indirectly acts as a softener by preventing the formation of the definite compound of iron and carbon, hence a high silicon accompanies a high graphite.

A glance at the table just given illustrates this feature, showing that as the amount of silicon decreases the amount of combined carbon increases.

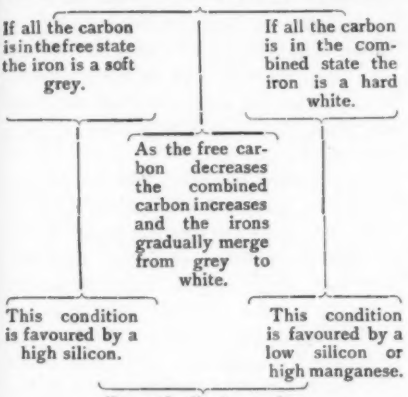
On the other hand, manganese promotes the combination of iron and carbon, thus indirectly acting as a hardener. Sulphur can only be regarded as an impurity, and the lower the content of this element the better for the castings. When in excess sulphur acts as a hardener by tending towards the production of a white iron, and it also leads to unsoundness in the castings.

Phosphorus promotes fluidity or "life" in the molten metal, but in the cold castings leads to brittleness. This element is, however, not nearly so injurious as sulphur, and to some extent is beneficial in light castings by its promotion of a thinly fluid metal which readily takes the finest impressions of moulds.

The foregoing notes represent only a *resumè* of the influence of composition for this feature has been already dealt with by the writer in the January, February, and March, 1903, issues of this journal. These articles, in conjunction with the present notes, for the present sufficiently illustrate the influence of composition. It is the application of this influence which chiefly concerns the Founder, and the question naturally arises, can the composition be regulated to meet the needs of a varied run of castings. It has already been shown that the amount of combined carbon determines chiefly the grade of the iron, and that this combination of iron and carbon is influenced by the presence of manganese and silicon. The following diagram illustrates these features. The

properties of cast iron are determined by:

THE AMOUNT OF COMBINED CARBON.


If all the carbon is in the free state the iron is a soft grey.
If all the carbon is in the combined state the iron is a hard white.
As the free carbon decreases the combined carbon increases and the irons gradually merge from grey to white.
This condition is favoured by a high silicon.
This condition is favoured by a low silicon or high manganese.
By gradually decreasing the silicon from 3 per cent. to 0·3 per cent. any variety of cast iron from full grey to white may be obtained.

PERCY LONGMUIR.

(*To be continued.*)

EARLY IRONWORKS IN AMERICA.

A MOVEMENT is under way among the iron manufacturers throughout the United States and members of the Leonard family of New England to erect a monument which will be one of the most notable memorials of the United States, since it will be celebrating what may claim to be the oldest successful ironworks constructed in America. Initial steps in the project have been taken by the Old Colony Historical Society, and the design prepared by Mr. Charles H. Hiehaus, of New York.

The monument will be of granite, while the fixtures, illustrating the primitive story of the ironworkers and other cognate subjects, will be cast in bronze. The monument will be erected at Taunton, Massachusetts, the site of the ironworks referred to.

The followers of Raleigh discovered ore-beds in North Carolina in 1585, but nothing was done to develop the deposit, although a report of discovery was made to the mother country. A year after the Jamestown Colony was founded in Virginia (1626), one of the company's ships left that place with a cargo not only of lumber but Virginia ore, which was smelted in England—the first iron manufactured from raw material procured in America. This fact encouraged the construction of several plants of English companies in the south, but owing to various misfortunes none were operated longer than a few years. In New England, however, the ore-beds were exploited at various points, the deposits along the Saugus River attracting special attention.

The ironstone was known to exist as early as 1629, and in 1642 specimens were taken to England, which resulted in the formation of "The Company of Undertakers for the Ironworks," consisting of eleven English gentlemen, who advanced £1,000 to establish the works.

John Winthrop, junior, had previously gone to England, and he appears to have assisted in securing the organisation of the company becoming a member of it, as did others of the colonists.

Mr. Endicott of Salem, in a letter to Governor Winthrop dated December 1st, 1642, says: "I want much to hear from your son's iron and steel." Thomas Dexter and Robert Bridges, both of Lynn (Mass.),were among the original promoters of the enterprise.

A foundry was erected on the west bank of the Saugus River. The village at the foundry was called Hammersmith by some of the principal workmen, who came from Hammersmith in England. The ironworks are said to have been located near the site of the present woollen factories in Saugus centre, not far from Lynn, where large heaps of scoria are still to be seen. This iron-foundry was undoubtedly the first to be established in America.

The metal industry has since developed

into very large proportions in this section of the United States, for in and about Lynn are foundries as well as wireworks, nailworks, and other plants of a smaller character.

There is no question but that the industry at Lynn, included not only the foundry but the refinery forge. The term foundry was long a synonym for furnace, castings being made directly from the furnace. This usage continued in America down to about the middle of last century. That the furnace was in operation in May, 1645, is certain, and that the forge was in operation in September, 1648, is equally certain. These dates may be accepted as definitely determining respectively the first successful attempts in America to make "sowe iron."

Joseph Jenks, who became the founder of a noted New England family, was a machinist at the Lynn works who had come from Hammersmith, and a man of much skill and inventive genius. He prepared the moulds for the first castings that were made at Lynn. "A small iron pot, capable of containing about one quart," was the first article cast at the furnace. It has been handed down in the Lewis family ever since. It is the old dinner-pot pattern, and, although holding only a quart, is heavy enough to make about three in the hands of the modern founder. The first iron utensil cast in America is now in the possession of the son of Alonzo Lewis residing at Lynn. Joseph Jenks in 1647 purchased from Richard Leader the privilege of building a forge at the Lynn ironworks for the manufacture of scythes and other edge tools. This enterprise was also successful.

In 1652 he made at these ironworks for the Mint, which was that year established at Boston, the dies for the first silver pieces coined in New England, known as the "pine-tree shillings," and in 1654 he built for the city of Boston the first fire-engine made in America.

In 1655 the general court granted him a patent for an improved scythe. Mr. Hawkes says of the scythe which he invented: "This improvement consisted in lengthening the blade, making it thinner and welding a square bar on the back to strengthen it, as in the scythe to-day." Before this the old English blade was short and thick like a bush-scythe; Jinks died in 1683.

The Leonard brothers, who have been called the pioneers of successful iron-making in New England, acquired much of their experience at Lynn, although they were forgemen in Monmouthshire, England, before coming to America. Undoubtedly the family name is the most noted in the annals of American iron industry. A well-known writer has said: "Where you can find ironworks, there you can find a Leonard." The first plant of which the Leonard took charge appears to be the one which is claimed to be the oldest successful iron industry in the colonies. This enterprise was undertaken in 1652, by a company composed of citizens of Taunton, who employed Henry and James Leonard as practical ironworkers. At a town meeting at Taunton, held Oct. 21st, 1652, "it was agreed and granted by the town to the said Henry Leonard and James Leonard, his brother, and Ralph Russell, free consent to come hither and join with certain of our inhabitants to set up a bloomery on Twomile River." The works thus projecting were put in operation in 1653. Thomas Leonard and his brother James succeeded their father in the works, and the family name was connected with the Taunton forge for many generations. Bar-iron was made directly from the ore, the works turning out twenty to thirty tons annually. In 1793, nearly 150 years after the fires were first lighted, Taunton forge was in operation, being kept in good repair. In 1851 it was reported that it was running full blast, although it had been in constant use for over two centuries, except when it was necessary to shut it down for repairs

and improvements. It was still held as the property of the Leonard family, being owned by Theodore Dean, a direct descendant of the Leonard. During the latter part of its career the plant was devoted largely to the manufacture of anchors, and hundreds of vessels sailing out of New England ports were equipped with anchors bearing its stamp. Until 1865 it was being utilised, and at that time contained four forge fires and two hammers. The buildings were unassuming frame structures situated on the border of the sheet of water from which power was secured by the mill-race. The works were notable for the quality of the iron produced.

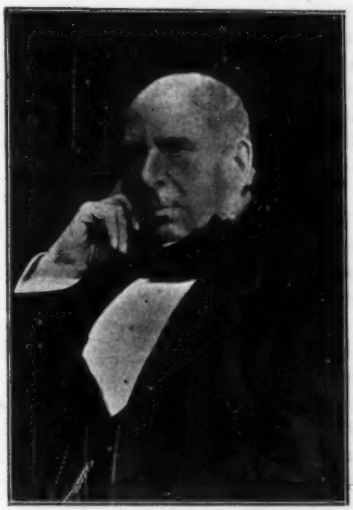
The statement made by the Leonard family that they were found wherever ironworks were established was made on good authority, as the history of the metal industry of New England shows. Henry Leonard was the founder of the ironworks located at Raleigh village, twenty-five miles north-east of Lynn in 1668. Later the works were managed by his sons. Henry Leonard was also identified with the Brain-tree works, where pots, motars, and skillets were cast. James Leonard built the Whittington ironworks on Mill River, 1670. He was senior forgeman, while his sons who had learned their trade at the Taunton plant worked the forge. The Chartley works (1698) constructed on Stony Brook, in what was called the Taunton North Purchase, were promoted by Thomas and James Leonard, and afterwards owned by George Leonard. Zephaniah Leonard was identified with the Hopewell plant built on Mill River in 1740.—*Chambers's Journal.*

PORTRAITS OF PIONEERS.

VI.—Sir Henry Bessemer, F.R.S.

HENRY BESSEMER was the youngest son of Antony Bessemer, a French scientist, who, ere the days of the great revolution held a post in the French Mint; but during the dictatorship of Robespierre was given charge of the public bakery in Paris. Without warning or reason Antony Bessemer found himself an object of dislike—a new whim had seized the excitable populace. He fled, and escaped to England. Here his talents found scope, and he was engaged in the Royal Mint, in London. By and by a small estate was bought in the village of Charlton, in Hertfordshire, and there Henry Bessemer was born on January 19th, 1813.

Amid rural surroundings his early life was spent, and his inventive spirit was



Sir Henry Bessemer, F.R.S.

encouraged in various ways. His father purchased for him a small lathe, of which young Bessemer became very fond, and with which he did some wonderful work. Clay modelling and steel engraving also engaged his attention. At the latter occupation he earned a good living in the production of designs on steel for labels for medicine bottles. His versatile mind found some scope in working out improvements in such diverse directions as type founding, ventilating of mines, designing of pumps, polishing of plate glass, and in the very profitable manufacture of bronze powder.

He devised a plan to check the stamp

frauds, by which the Government lost at the rate of £100,000 per annum, and was offered a post at £600 a year in the stamp office. Owing to change of government that appointment was not confirmed.

When the Crimean war broke out Bessemer gave his attention to war material, and he submitted a style of shot which the Woolwich officers, with true official obstinacy, rejected without a trial. But the late Emperor of the French on learning from Bessemer of his project, gave him a blank cheque, and urged him to continue his experiments. These were so highly successful that a stronger material for guns was desired, and a hint was given which was taken up zealously. His first idea was to improve the quality of cast-iron, then, as he worked, he aimed at improving the manufacture of wrought iron, and from that he was led up to try a method for cheapening the production of steel.

One of his early experiments was tried in a clay-pot, with a ¾in. gas pipe coated with fire-clay for a tuyere, and it became apparent that by blowing air through molten pig-iron an intensely high temperature could be attained and purification effected. Therein lay the germ of the Bessemer process. A "converter" was set up and in the autumn of 1856 the attention of eminent engineers was directed to the new departure. These engineers remained firm friends of Bessemer through good report and ill. The early experiments were most successful, and Bessemer received £27,000 for licenses to work his patent. But, somehow, when the process was tried in works, it was a complete failure! The iron-masters and the press joined in a chorus of condemnation, and he was described as "a brilliant meteor who had flitted across the metallurgical horizon, dazzling a few enthusiasts, and had then vanished for ever in total darkness." But Bessemer bought back the licenses and resolved to master the difficulty.

Undaunted by a constant succession of newly-formed hopes and crushing defeats, he plodded on for many months although much worn by hard work and worry. Some friends tried to dissuade him from prosecuting what the trade said was an impossibility. He knew better: he persevered and mastered the matter. He found out how to regularly produce good steel, at a price far below the ordinary cost.

The trade was sceptical, but he conquered by the bold expedient of establishing a steel works of his own in Sheffield. The new process was so genuinely good that it could not be ignored. After the steel-makers had been won over, the consumers had to be convinced and that was no easy task. Engineers were shy, and slow to adopt the untried material. But in time too, they were converted—the new material was much cheaper.

Bessemer received in royalties over a million pounds. The works which he started in Sheffield repaid all the invested capital every two months for twelve years. European emperors and kings did themselves the honour of honouring Bessemer's great genius and work. The Americans named six towns after him. Learned societies showered honours on him, and lastly, the British Government recognised his splendid services.

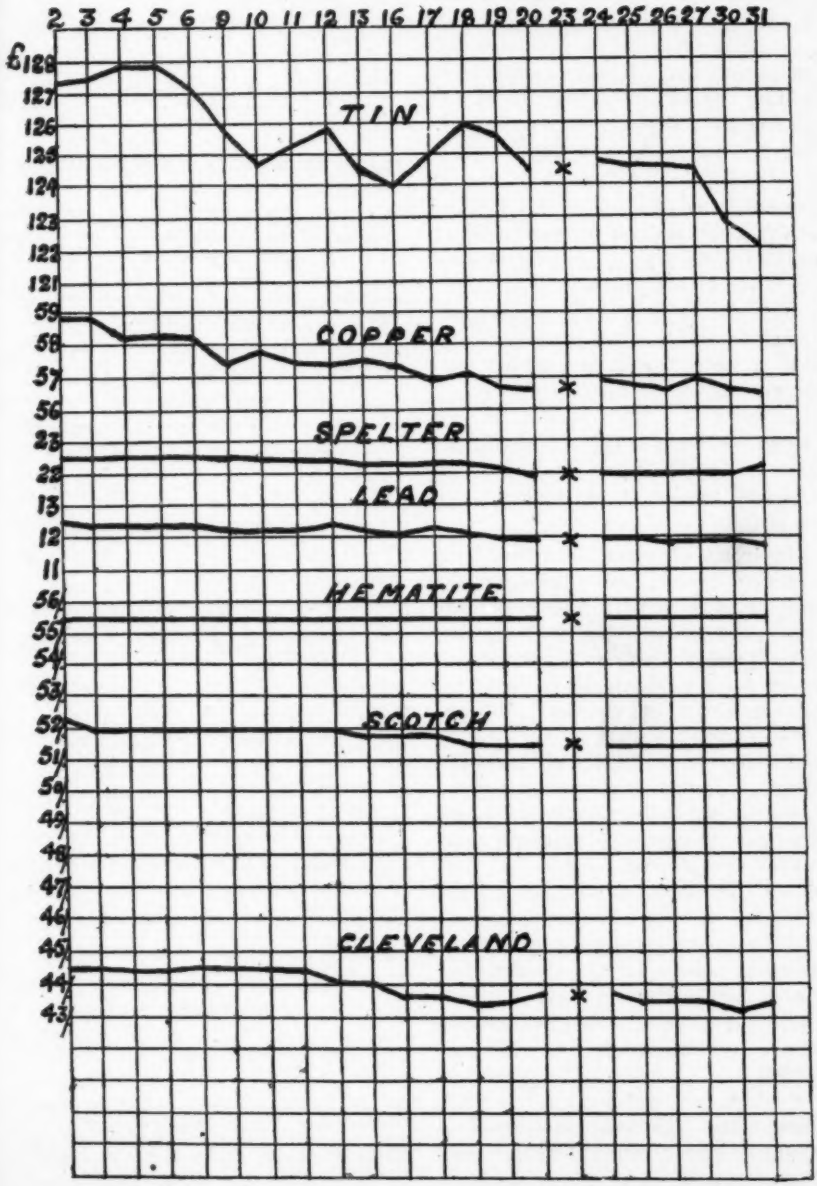
He died on March 15th, 1898.

Not only in material wealth, but in the brilliant example of industry and honesty of purpose, the world has been greatly enriched by the life and work of Bessemer.

WALTER MACFARLANE, F.I.C.

Sara Spedito THE FOUNDRY TRADE JOURNAL *per il periodo di un anno in qualsiasi paese, franco di posta, dietro pagamento di* 9 *franchi e* 50 *centesimi. Detta somma deve esser e rimessa con vaglia internazionale o con cheque pagabile in Inghilterra.*

CHART OF THE FLUCTUATIONS OF THE METAL MARKET IN MAY.



METAL MARKET REPORT.

LONDON, May 31st.

TIN has been in fair demand, and the market steady; but prices have fallen off, owing to coverings and forward sellings. Weaker cables from the East caused a sharp decline on the 30th and 31st; closing price on the 2nd, £127 7s. 6d.; on the 31st, £122.

* * *

Copper has experienced a somewhat slack demand, and the market irregular; prices fell from £58 17s. 6d. on the 2nd, to £56 10s. on the 31st.

* * *

Spelter.—Firm, in good demand. Price on the 2nd, £22 10s.; on the 31st, £22 5s.

* * *

Lead has been in quiet demand, and shows a falling-off in price from £12 10s. on the 2nd, to £11 15s. on the 31st.

* * *

Pig-iron.—Cleveland iron has been in strong request, and production not equalling the demand. Consumers have often found great difficulty in getting delivery, and ships have sometimes had to wait for the iron to be made before they could complete cargoes. The export account has been good for Foundry iron; very little forge iron has been shipped. Notwithstanding the demand being greater than the supply, prices continue to drop, mainly owing to the weakness in the Warrant market. Closing prices: On the 2nd, 44s. 6d.; on the 31st, 43s. 5d. In Scotland the iron market has been dull, what demand there was being mainly for Cleveland makes. The Warrant market has been absolutely idle. The price of Glasgow iron fell from 52s. 3d. on the 2nd, to 51s. 6d. on the 31st.

* * *

Hematite.—There is no improvement to report in the trade in hematite irons. West Coast makes show no improvement at all, but price is maintained at 55s. 6d. f.o.b.

PUBLIC STORES STOCKS OF PIG-IRON IN TONS.

	June 2, 1904.	June 4, 1903.	Decrease.
Connal's at Glasgow	9,600	15,600	6,000
Connal's at Middlesbrough ...	84,860	143,300	58,440
Connal's at Middlesbrough hematite ...	300	300	...
West Coast hematite	14,630	21,270	6,640
Totals ...	109,390	180,470	Net. Dec. 71,080

* * *

PRICES OF WHOLESALE COMMODITIES.

APPROXIMATE prices and position at latest date for which statistics are available, with prices and quantities at the corresponding dates in each of the last two years:—

METALS.	1904.	1903.	1902.
Iron—Scotch pig warrant ton	.....Nom.	.....52/6	..... 54/1½
—Middlesbro' warrants ton	..... 42/7½	..... 45/8½	..... 49/2½
—W.C. M/nos Bessemer ton	..... 55/6	.....59/6	.....60/0
—Staffordshire bars, Lond. ... ton	£6 10—£8 10	.....£7—£7 5	.....£8—£8 5
—Welsh bars, Wales... ton	... £6—£6 5	.. £6—£6 5	.... £6—£6 5
—Stock, Scotch, June 10 tons	 9,565	15,337	52,539
Copper—Chili bars, GMB ton	..... £56 10	56 15–56 16 3	£54 7/6–54 8/9
—Stock, Europe and afloat... tons	10,823	15,764	24,264
Tin—English ingots ... ton	£123 10–£124	..... £127	£130—130 10
—Straits ton	121 15–121 17/6	£126—126 2/6	£131—131 5
—Stock, Ldn, Hlnd. and afloat... tons	10,532	10,342	10,475
Tinplates—Charcoal I.C..... box	.....12/6—14/0	..... 13/0—14/6	.....14/6—16/0
Lead—English pig ton	11 17/6—12 0	11 12 6—11 15	11 10—11 12 6
Spelter—Ord. Silesian ton	21 15—21 17/6	£21—£21 7/6	18 12/6—18 15
Quicksilver—(75lb.) bottle	..... £8	.....£8 12/6	..... £8 15
Antimony—Regulus ton	£27 10—£28	£27—£27 10	£29 10—£30
Coal—Lyons Wallsend, London ton	..... 13/0	.....15/0	.....17/0

The following are the shipments of pig-iron from Middlesbrough, according to Messrs. Wm. Jacks & Co., Middlesbrough, June 9th, 1904:

DESTINATION.	Last Month to 9th.	June to 9th			5m. ended May 31st,	
		1904.	1903.	1902.	1904.	1903.
Scotland ...	12,867	9,832	15,504	8,938	200,019	214,373
England & Wales ...	2,205	2,970	7,375	2,743	48,427	75,488
Foreign.....	12,868	12,494	16,617	6,078	222,483	224,071
Totals ...	27,940	25,296	39,496	17,759	470,929	513,932

NEW INVENTIONS.

List specially compiled for THE FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Patent Expert, 77, Colmore Row, BIRMINGHAM, from whom all further information may be obtained regarding the Patenting of Inventions, the Registration of Designs and Trade Marks in England and abroad.
Telephone No. 1,300. Telegraphic Address—"PATENT, BIRMINGHAM."

APPLICATIONS MADE FOR PATENTS RECENTLY.

Improvements in and relating to Foundry core-making machines	J. W. Phillips & S. Holt ...	1570
Improvements in supports for cores used in Foundries	H. Sonnet	5780
Improvements in moulding machines ...	C. Herman	6556
*Improvements in the manufacture of iron and steel	A. Zenzes	6997
Improvements in means of producing metal or metals or the like	E. Mollard	4343
A new or improved means for the recovery of metallic bases or compounds from their acid solutions ...	A. Gutensohn	4462
Improvements relating to machines for bending metals.	A. Coche & J. Chassignole ...	4511
*Improvements in casting wheels ...	W. R. Green	4614
Improvements in or relating to the separation of metals from their ores	J. D. Wolf	4793
Improved plate rolling mill	W. Lees	4848
Improvements in machines for folding metal sheets or plates	B. H. Doll	5018
Improvements in three high mills for rolling metal...	J. Calderwood & J. A. Parker...	5337
Improvements relating to power presses and similar machines for stamping and pressing sheet metal or for like purposes	H. A. & R. H. Griffiths... ...	5423
Process and apparatus for heating the dead heads of steel ingots or blocks while in their moulds	A. G. Bloxam	5681
*Improvements in plate bending and straightening machines	Craig & Donald Ltd., & C. Patrick	5868
An apparatus for corrugating and shearing sheets or plates to any length or number of corrugations for one continuous motion	A. G. Jeynes & G. W. Green ...	5982
Improvements in machines for bending rolled iron and other metal bars and the like of various section	W. Taylor	6181
Improvements in apparatus for the manufacture of alkali metal	A. G. Haddock	6336
Improvements in and connected with the manufacture of alkali metal	A. G. Haddock	6337

Applications marked with an asterisk (*) denote complete applications.

No. 577/1903. J. E. BURKILL and W. SUNDERLAND, both of Wakefield.

This invention comprises an improved machine for moulding cores or patterns by compressed air or hydraulic power, in which the exhaust is used for drawing or turning out the core.

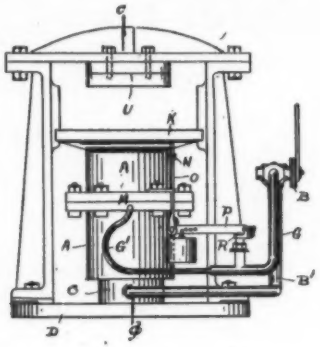


Fig 1

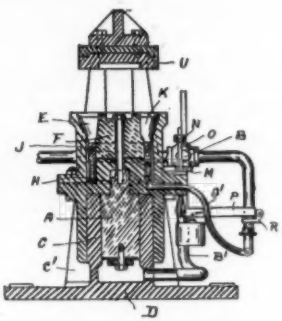


Fig. 2

Fig. 1 is a front elevation, and Fig. 2 a vertical section on line *c d* of Fig. 1.

In carrying out this invention, the admission of the water or air to operate the ram A is controlled by a suitable three way cock B. The air cylinder C and bed plate D are made in one piece. The ram A works upwards, the sand being filled into the recess E around the die F attached to the ram. On the completion of the upward stroke of the ram, the catch M engages with the adjustable nut N attached to the lever O, thereby raising the weighted lever P. The admission port in valve B being closed, leaves open the port to the chamber C^1 and also the port to the exhaust pipe G and flexible pipe G^1. These ports being opened, a certain amount of air is allowed to escape back through the pipe B^1, valve B and pipe G, and out through the escape valve R, thus allowing the ram to fall by reason of its weight overcoming the pressure in chamber C^1. The valve R is then automatically closed by reason of the lever O; being brought to its normal position by weighted lever P, and the remaining air is forced by the descending ram through pipes B^1, G, and G^1 to the annular space H, provided underneath the ring tube J, which forms an air piston supporting the bottom of the core or cake. The air passing to the previously mentioned annular space H raises the air piston J until the finished core is pushed or blown lever with the top K of the main piston or cylinder, when the cake may be removed.

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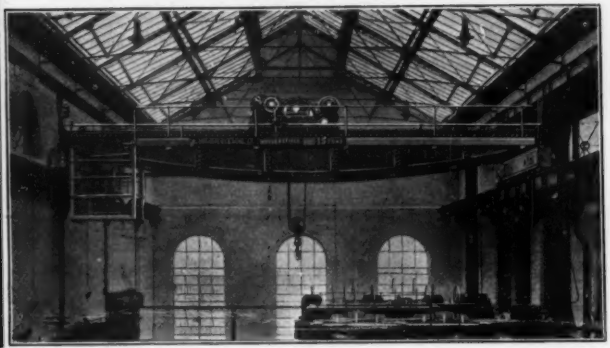

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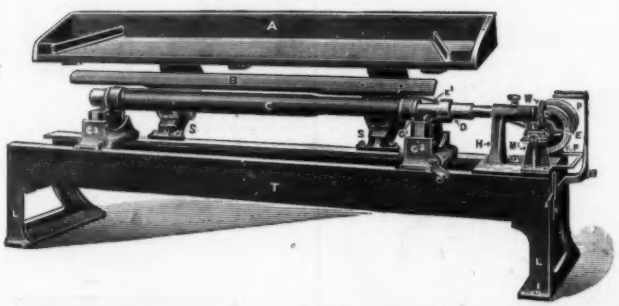

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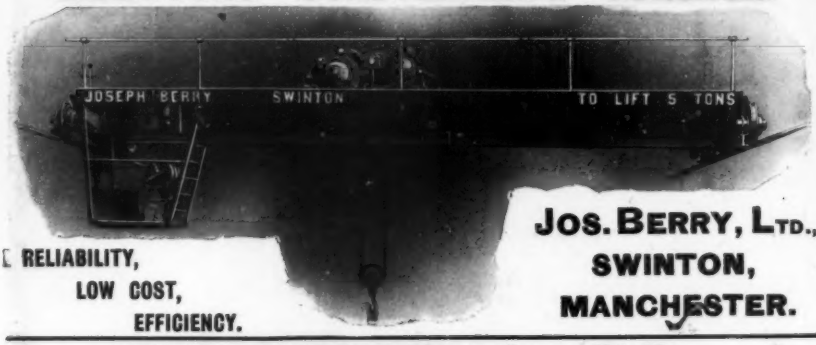

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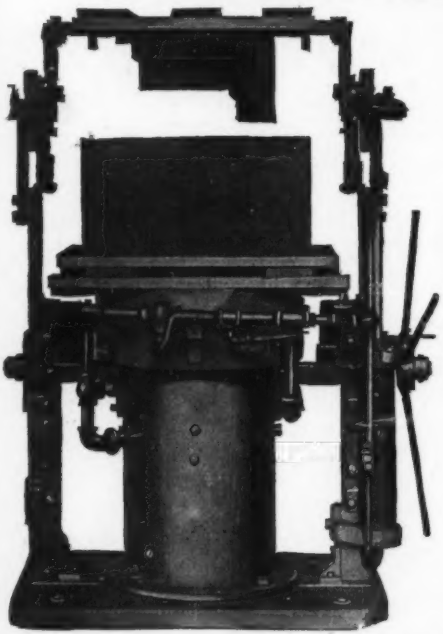

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